Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

- FINAL -

Task 2 Laws & Management Plans Report

Part 2: Review of Published Plans, Policies, Procedures, Guidelines and Recommendations that are Directly or Indirectly Related to Vector Control Activities

Prepared for:

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List of Acronyms and Abbreviations

AMCA	American Mosquito Control Association
Bti	*Bacillus thuringiensis israelensis*
CAF	Coastal Assessment Form
CCMP	Comprehensive Conservation and Management Plan
CDC	Centers for Disease Control and Prevention
CNRA	Critical Natural Resource Area
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendments
CZMA	Coastal Zone Management Act
DEET	N,N-diethyl-meta-toluamide
EEE	Eastern Equine Encephalitis
EIS	Environmental Impact Statement
ELISA	enzyme-linked immunoabsorbent assay
FINS	Fire Island National Seashore
IMM	Integrated Mosquito Management
IPM	Integrated Pest Management
LISS	Long Island Sound Study
LWRA	Local Waterfront Revitalization Area
LWRP	Local Waterfront Revitalization Program
MOU	Memorandum of Understanding
NEP	National Estuary Program
NJMCA	New Jersey Mosquito Control Association
NPEDES	National Pollutant Discharge Elimination System
NPS	US Department of the Interior National Park Service
NPS	non-point source
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
OMWM	Open Marsh Water Management

PCR	polymerase chain reaction
PEP	Peconic Estuary Program
PESP	Pesticide Environmental Stewardship Program
SCDHS	Suffolk County Department of Health Services
SCDPW	Suffolk County Department of Public Works
SCVC	Suffolk County Department of Public Works, Division of Vector Control
SEQRA	State Environmental Quality Review Act
SGPA	Special Groundwater Protection Area
SSER	South Shore Estuary Reserve
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WNV	West Nile Virus

EXECUTIVE SUMMARY

Task Two of the Suffolk County Vector Control and Wetlands Management Long-Term Plan and Generic Environmental Impact Statement Project was to generate discussions of the management plans and guidances, and laws, regulations, and other legal aspects, as they relate to vector control in Suffolk County. This Task Two Part 2 Report addresses management plans and other published policies, procedures, guidelines and recommendations that directly or indirectly apply to vector control activities.

Guidance regarding mosquito control operations generally addresses the two broad areas employed to reduce these pests. These are pesticides and water management.

Overall, all authorities call for reductions in the use of pesticides. Pesticide usage is regarded as something that may increase potential risks to human health and the environment, whether or not the pesticides so used are being applied in an approved fashion. If pesticide use can be reduced with no loss in mosquito control, then potential risks to human health and the environment should be less. Thus, reductions in the number of applications and overall volume of pesticide usage are generally endorsed[1].

However, human health emergencies take precedence over the broader guidance to reduce pesticide applications. This is because mosquito-borne diseases represent clear and defined threats to human health and may result in fatal illnesses. The potential damage to human health and the environment from pesticides is generally not perceived to be as immediate as the risk posed by these diseases. Therefore, in situations where pesticide usage is believed to be capable of reducing the chance of human disease, pesticide use is (generally) recommended.

[1] There are programmatic reasons for minimizing reliance of pesticides for mosquito control. One is that operational difficulties can thwart the planned application of pesticides (due to weather or logistical complications, for example). Secondly, Integrated Pest Management calls for the use of multiple means of control to reduce the development of resistance to particular pesticide formulations. Thirdly, particular pesticides may constitute limited markets, and overreliance on one or two chemicals may lead to the risk of the manufacturer stopping production and threatening the effectiveness of the pest control program.

Some documents, such as National Park Service guidance for Fire Island National Seashore, are very specific about the graduated levels of responses that may eventually lead to pesticide use. Others have more general approaches to these kinds of guidance, usually supporting a hierarchical approach (Integrated Mosquito or Pest Management) where pesticide applications are the action of last resort. A notable exception to the general rule is the New York State Department of Environmental Conservation preference for larvicide applications instead of habitat modifications as the preferred means of controlling mosquito populations in freshwater wetlands.

In general, Federal and State guidance call for specific decisions regarding vector control to be made at the local level. The Federal and State guidelines generally give a planning and decision-making framework that should be implemented, and so set the stage for any determinations that may lead to the declaration of an emergency or other incremental changes in the level of response required to address a vector problem. However, the final determinations as to when and exactly how to implement the framework are left to local decision-makers.

Planning documents that directly discuss mosquito control tend to call for a reliance (or priority) on source control measures. Therefore, water management is encouraged in many of these documents. Exceptions are mostly limited to areas where other public policies have established a priority for natural processes over active human management of the environment. Specific examples of these include National Park Service guidance for Fire Island National Seashore, especially the wilderness areas, US Fish and Wildlife Service guidance for wilderness and unditched areas of national wildlife refuges, and the previously mentioned New York State Department of Environmental Conservation guidelines for freshwater wetlands.

Those guidances that call for water management generally specify the use of Open Marsh Water Management (OMWM). OMWM is a guild of techniques; these methods were developed to address perceived environmental impacts from the implementation and maintenance of wetlands ditching ("traditional water management"). Sometimes OMWM is applied as a restoration program, but, in the context of vector control, OMWM techniques are active means of source control that address mosquito development in wetlands (primarily by encouraging native fish to have greater access to mosquito breeding points, and so having the fish consume the larvae), and,

at the same time, also reduce traditional water management impacts to the environment by restoring water levels in the marshes.

Traditional water management (marsh ditching) finds little favor in most of the reviewed documents. This is because traditional water management is thought to be overmanagement of the sensitive shoreline environment, and to result in the loss of key elements of the natural suite of wetlands habitats. Some of these key elements are marsh surface waters (ponds and "pannes," important as for waterfowl habitat) and the distribution of wetland plants (which may affect overall diversity of the wetland)[2].

OMWM is often cited as a replacement for traditional water management. All of the major surface water management plans for Long Island (the Long Island Sound Study, the Peconic Estuary Program, the South Shore Estuary Reserve) recommend the use of OMWM in some fashion as part of their overall management approaches. However, some of the reviewed management plans may not acknowledge the potential for OMWM to also require significant alterations to the in-place environment. For example, some plans explicitly support the use of OMWM, but also declare opposition to ditching and ditch maintenance. For mosquito control purposes, OMWM requires construction of fish reservoirs and access waterways to breeding areas, and may require long-term maintenance. Therefore, typical OMWM installations for mosquito control purposes may seemingly result in some conflicts with some goals and objectives of the guidance documents.

Part of the confusion may arise from restorations of water levels in ditched marshes by building earthen plugs to mosquito control ditches. This technique is widely called OMWM. Vector control professionals believe that all true OMWM activities need to be designed to affect mosquito populations, and the construction of ditch plugs does not explicitly address this need.

The Long-Term Plan therefore provides an opportunity to resolve aspects of certain of the management plans which, perhaps, have some apparent conflicts. Guidances that may need

[2] A complete discussion of the impacts of ditching wetlands for mosquito control purposes (including potential benefits to the technique) can be found in the Task 3 Literature Search Report , Book 9 "Salt Marshes and Mosquito Control", Chapter 5 ("Impacts of Historic Ditching and Standard Water Management").

some refinement appear to be ditching prohibitions versus OMWM installations, and some preferences for ditch reversion in light of recommendations for pesticide use reductions (since water management is identified as an effective means of limiting pesticide applications).

Many of the Long Island habitat-oriented guidance documents do not discuss water-related goals in light of mosquito-borne disease control, even in this age of West Nile Virus. This is especially true of guidance oriented for inland areas (although freshwater mosquitoes appear to be the primary vector for West Nile Virus). In part, this is due to the relatively low rank of fresh surface waters in the hierarchy of Long Island environmental concerns.

A mosquito control program that relied on grid-ditch maintenance, or that primarily relied on chemical controls, would find itself in conflict with most of the reviewed documents. On the other hand, most of these policy statements support (at least implicitly) Integrated Mosquito Management-based programs that use OMWM as primary means of water management in salt marshes, and where adulticiding using pesticides is the last-resort option, used only in health emergencies.

1 Overview

This section of the Task Two "Laws and Management Policies" Report summarizes the findings and recommendations of a comprehensive review of existing Federal, State, regional, county, and local planning and research initiatives which either directly or indirectly address vector control issues and activities. Formal Suffolk County plans, either issued by Suffolk County Department of Health Services (SCDHS) or as expressed through the Plans of Work that Suffolk County Vector Control (SCVC) is required to submit to the legislature each year, will be discussed in the Task Four Report that addresses past and existing County vector control activities.

It should be noted that although it is important (and sometimes necessary) to consider these existing plans and studies prior to implementation of some form of mosquito control, this review should not be considered an exhaustive compilation of literature on the subject. Some of the most important issues, including those which have survived particularly rigorous reviews and analyses, are the laws enacted by the various levels of government. The laws impacting vector control activities will be addressed in Part 1 of this Task Report (separate cover).

There are several guidances that are intended to specifically guide mosquito control efforts. These include work by the US Environmental Protection Agency (USEPA), and, especially, reports published by the Centers for Disease Control and Prevention (CDC) and the New York State Department of Health (NYSDOH) in response to the outbreak of West Nile Virus (WNV). Some specific guidance documents that directly impact Suffolk County mosquito control efforts have also been released by the National Park Service (NPS), the US Fish and Wildlife Service (USFWS), and the Peconic Estuary Program (PEP). There are also a great many policy and management initiatives which indirectly affect mosquito control through general wetlands management, protection of critical natural resources, and policies relating to the use of pesticides, and concerns regarding WNV and Eastern Equine Encephalitis (EEE).

Much of the literature that was reviewed consisted of comprehensive resource management plans which addressed such large and critical resources as the Long Island Sound, the South Shore Estuary, Peconic Estuary, the Central Pine Barrens, and Long Island's sole source aquifers. These documents tend to be quite lengthy and involve ongoing comprehensive planning

initiatives, public outreach, and implementation efforts. For instance, the voluminous *PEP Comprehensive Conservation and Management Plan (CCMP)* (as with similar efforts for the Long Island Sound Study [LISS] and the South Shore Estuary Reserve [SSER]) discussed resource protection (including wetlands) extensively. However, the PEP CCMP also contained numerous specific mentions and brief comments of vector control and Open Marsh Water Management (OMWM) issues. The others tended not to be as specific.

Other literature reviewed included more broad-based documents and policies. One example is USEPA's *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), which addresses general stormwater control issues across the country. Although not specific to the vector control issue, this guidance manual thoroughly addresses stormwater management approaches, including the use of stormwater control structures, as well as some general wetlands issues. Stormwater control structures and wetlands often provide prime mosquito habitat and breeding areas and therefore, any activities to construct or modify these features are important to the control of mosquitoes.

Other documents may also have established management guidelines in indirect methods. For example, the New York State Department of Environmental Conservation (NYSDEC) published a review of laws and regulations controlling mosquito management in the state (NYSDEC, 2000). In this review, NYSDEC discussed its preferences for preferred mosquito control methodologies in particular habitat settings – an extension of the laws that creates public policy.

A more encompassing discussion of the literature reviewed is provided below. Some of the policies and recommendations from these documents are provided verbatim, so as not to unnecessarily or unwittingly alter the general purpose, meaning, and intent of their authors.

Finally, as with any regulated activity it is incumbent upon those undertaking certain regulated or guided actions to ensure that adopted procedural and regulatory standards and guidelines are up-to-date and that these standards and guidelines are adhered to. This compliance should include contacting the appropriate agencies and authorities or collecting and reviewing the appropriate guidance documents before commencing an action.

2 Federal Guidance and Management Plans

2.1 Pesticide Environmental Stewardship Program (PESP) (USEPA, 2001)

This is a voluntary program created by USEPA to reduce environmental risks associated with pesticide use below those established under regulatory programs. Because it espouses doing more than is required under regulations, the program is entirely voluntary. As of 2003 (the date of the last update of the PESP website), there were 117 listed members of PESP, along with many supporting members (organizations such as food processors with a vital interest in reducing pesticide use).

Organizations joining PESP adopt the principle that environmental stewardship is integral to pest control. Environmental stewardship is defined as "safeguarding human health and the environment in order to sustain or improve the quality of life for ourselves and future generations." To achieve that end, PESP members are urged to use innovative, alternative pest control practices. USEPA provides a liaison to the member organizations, and has pledged some financial resources to help members find workable alternatives to potentially harmful chemicals. Member organizations are not required to renounce the use of synthetic chemicals, however.

Some particular innovative approaches identified by USEPA include:

- Microbial pesticides
- Use of pheromones (which disrupt mating or serve as lures)
- Use of clays or other non-synthetic materials (such as baking soda) to smother or otherwise prevent pest growth

USEPA also strongly supports the hierarchy established under Integrated Pest Management (IPM). IPM is an ecologically based strategy that relies on natural mortality factors and seeks out control tactics that are compatible with or disrupt these factors as little as possible. IPM allows for pesticide use, but only after systematic monitoring of pest populations indicates a need. Ideally, an IPM program considers all available control actions, including no action, and evaluates the interaction among various control practices, cultural practices, weather, and habitat structure. This approach thus uses a combination of resource management techniques to control pest populations with decisions based on surveillance. Fish and game specialists and natural resources biologists should be involved in planning control measures whenever delicate ecosystems could be impacted by control practices. PESP says IPM "weighs costs, benefits, and

impacts on health and the environment. Options include prevention, monitoring, mechanical trapping devices, natural predators, biological pesticides, and, if appropriate, chemical pesticides."

2.1.1 American Mosquito Control Association (AMCA) membership (AMCA, 2003)

AMCA is a member of PESP, and has in fact been designated as a PESP "champion." Member organizations of AMCA can achieve PESP certification under its umbrella certification. This eliminates the need for the particular mosquito control agency to formulate its own strategic approach, and minimizes the management effort for USEPA.

In 2002, AMCA established four activities to pursue to reduce risks associated with pesticide use by its members. They were:

1) As part of AMCA's approach to pesticide risk reduction, conducting research and implementing proven technologies to optimize pesticide targeting and efficacy will be pursued.

In 2003, its report showed that members had calibrated the delivery of adulticides from aircraft and trucks, and that a major research program had been undertaken in Florida to improve the delivery of larvicides to mosquito habitat under forest canopies.

2) The AMCA believes that the greatest strides in reducing mosquito pesticide risk are achieved through the continuing education of mosquito control workers. Consequently, numerous states around the country have educational programs which lead to workers being able to achieve certification in "Public Health Pest Control" (or some similar title). The AMCA will continue to strongly encourage the implementation and enhancement of such education/certification programs.

The 2003 report showed over 2,300 workers receiving some formal training in 2002, with over 900 achieving certification (making the total of certified workers 4,400 nationwide).

3) The AMCA believes that important strides in reducing mosquito control pesticide risk are achieved through public education. As such, the AMCA strongly encourgages the development and continuation of such educational programs. Many mosquito control programs around the country carry out innovative and imaginative public education programs which lead to a better-informed public about mosquito control issues and pesticide use.

4) The AMCA believes that important strides in reducing pesticide use are achieved through careful surveillance for mosquito-transmitted pathogens of public health significance (e.g., the virus that cause St. Louis encephalitis, West Nile, eastern equine encephalomyelitis, western equine encephalomyelitis). If surveillance data indicates the presence of a pathogen, appropriate actions can be taken which can include more carefully directed pesticide applications. With the occurrence of West Nile Virus in North America originating in the New York City area in 1999 and spreading this past summer, surveillance information takes on added significance.

AMCA pointed out that in 2002 WNV spread to as far south as the Florida Keys and as far west as the state of Washington, with 4,019 cases being reported. This, in addition to ongoing efforts to identify other pathogens and their vectors lead to increased surveillance activities nationwide.

For 2003, AMCA continued to stress activities 2, 3 and 4. However, it substituted the following for activity 1 (as used in 2002):

1) As part of the AMCA approach to pesticide risk reduction, the implementation of environmentally-sound source reduction techniques (typically in wetlands) is being widely encouraged among its membership. Also, urban source reduction (e.g., waste tire and container removal) is an important source reduction effort with significant localized benefits.

It was pointed out that the elimination of breeding areas necessarily reduces the impetus to apply pesticides for mosquito control. AMCA hoped to be able to document the acreages of wetlands now being managed, and to discuss urban source reduction implementations in its 2004 report.

2.1.2 New Jersey Mosquito Control Association (NJMCA) adaption of PESP principles (NJMCA, 1997)

NJMCA used the opportunity of its membership in PESP to make an overall statement regarding its strategies for responsible mosquito control. Although SCVC is not bound by the policies of NJMCA, it was pointed out that NJMCA altered and specified the generalized PESP guidelines, and that this document could be of benefit to SCVC in considering its own overall approach.

Specifically, NJMCA (after specifying its administrative structure, which include oversight and review by Rutgers under New Jersey state law) proposed the following as the means by which responsible mosquito control can be achieved:

1) Surveillance, including post-treatment. Surveillance should include larval, adult, and virus components.
2) Source reduction. Source reduction occurs over two broad categories: sanitation and water management. Sanitation includes addressing byproducts of human activities, and may include the invocation of police powers to abate identified public health nuisances. Water management includes freshwater and salt water components. A Best Management Practices manual has been generated for freshwater environments. These practices may not be entirely useful in New York, as small freshwater wetlands areas are not regulated as tightly in New Jersey, allowing for manipulation of these environments as a matter of course (W. Crans, Rutgers University, personal communication, 2004). The two thrusts regarding salt water marshes are the Tidal Restoration of Salt Hay Impoundments and the use of OMWM. OMWM is a group of similar marsh water management techniques that is intended to restore water levels in a wetland from the "drained" level that occurs following the construction of grid (or parallel) ditches, and yet also to continue to control adult mosquito production. OMWM primarily controls mosquito production by inducing fish access to formerly isolated areas where mosquito larvae may undergo metamorphosis to adults (Wolfe, 1996).
3) Chemical Control. Larviciding is the preferred element for primary chemical control. Adulticiding is allowed once biting populations reach a "critical" level.
4) Biological control. The use of biological controls, primarily through stocking fish or improving fish habitat, is lauded as it is generally host-specific, and has few non-target impacts.
5) Education. Education should include continuing education for professionals (there have been monthly meetings of the Associated Executives of Mosquito Control Work in NJ since the 1920s, for example, and the annual NJMCA conference has published its technical proceedings for nearly as long). It also includes education of the public to understand mosquitoes and their tendencies, and to encourage source control.

2.2 USEPA/CDC Partnerships and Initiatives

The World Health Organization estimates that more than 300 million clinical cases each year are attributable to mosquito-borne illnesses. Mosquito-borne illnesses continue to pose risks to the United States. USEPA and the CDC are working closely with each other and with other Federal, state, and local agencies to protect the public from mosquito-borne diseases such as WNV.

2.2.1 Generalized Roles

CDC, working closely with state and local health departments, monitors the potential sources and outbreaks of mosquito-borne diseases and provides advice and consultation on prevention and control of these diseases. CDC works with a network of experts in human and veterinary medicine, entomology, epidemiology, zoology, and ecology to obtain quick and accurate information on emerging trends. CDC is charged with using this information to develop national strategies that reduce the risk of disease transmission.

USEPA has a role in ensuring mosquito control agencies have access to effective tools that can be used without posing unreasonable risk to human health and the environment. USEPA encourages non-chemical mosquito prevention efforts (such as eliminating standing water that provide breeding sites). USEPA conducts outreach efforts to encourage proper use of insect repellents and mosquitocides. Additionally, USEPA has a pesticide review process leading to the production of label directions and precautions for mosquitocides to balance the need to reduce mosquito populations and minimize environmental impacts.

2.2.2 Integrated Mosquito Management (IMM)

USEPA and CDC encourage maximum adherence to IPM in all guidance documents. IPM has been adapted to mosquito management, and this implementation is known as IMM. The underlying philosophy of IMM is that the greatest control impact on mosquito populations will occur when they are *concentrated, immobile* and *accessible*. This emphasis focuses on habitat management and controlling the immature stages before the mosquitoes emerge as adults. This policy reduces the need for widespread pesticide application in urban areas.

USEPA and CDC recommend that professional mosquito control organizations throughout the US use IMM strategies. Both agencies recognize a legitimate and compelling need for the

prudent use of aerosol applications of pesticides, under certain circumstances, to control adult mosquitoes. The conditions that dictate such applications include periods of mosquito-borne disease transmission, or when source reduction and larval control have failed or are not feasible.

To be of maximum effectiveness, the people for whom protection is provided must understand and support mosquito control. An integral part of IMM therefore is public education. It is important that residents have a good understanding of mosquitoes, the benefits realized from their control, and the role people can have in preventing certain mosquito-borne diseases. Being aware of pesticide application times is also important for individuals so they may decide on precautions they may wish to take. While this usually involves education of the public through announcements in the media, some programs have staffs that develop and present educational programs in public schools and other forums. People who are informed about mosquito biology and controls are more likely to mosquito-proof their homes and eliminate mosquito breeding points on their own property.

2.2.3 Specific CDC Guidance Documents

2.2.3.1 Guidelines for Arbovirus Surveillance Programs in the United States (Moore et al., 1993)

This document, although written prior to the break out of WNV in the US, is still valuable in that it establishes standard procedures to be followed in monitoring and controlling mosquito-borne diseases. A generalized risk assessment profile methodology was presented, followed by specific monitoring and surveillance methodologies for the (then) four mosquito-borne encephalitises. In particular, a clear discussion of how to monitor for EEE was presented. The emphasis is on meteorology (two consecutive years of above-average rainfall, generally, as a predictor of *Culiseta melanura* populations), vector abundances (both enzootic host and the epizootic species that transmit the disease to people and animals), passerine bird infection rates, and seroconversions of chickens and unvaccinated horses (as sentinels).

The report included a long section on mosquito trapping technologies.

2.2.3.2 Epidemic/Epizootic West Nile Virus in the United States: Revised Guidelines for Surveillance, Prevention, and Control (CDC, 2001)

This report was the outcome of a conference held when it was apparent that WNV would be a persistent, recurring disease in the US. CDC set up a multi-pronged approach to managing human risks from the threat:

- Surveillance for WNV activity
- Laboratory diagnosis of WNV
- Prevention of disease transmission through mosquito control
- Proper response by public health agencies
- Communication among Federal, state, and local involved parties
- Establishment of research priorities

Surveillance should begin with bird monitoring, especially for dead crows (and other species in the *Corvidae* family). Mosquito population monitoring of potential vector species (not only bird-feeding mosquitoes, but also mammalian feeders) was recommended. Passive veterinary surveillance for horse neurologic infections (and those in other mammals, as well) was thought to serve as a backup for the two main surveillance efforts. Finally, passive human monitoring for encephalitis (and, potentially, meningitis) cases was called for.

Specialized diagnosis knowledge and equipment is necessary for WNV. The document spelled out the requirements to successfully determine the virus using ELISA and PCR tests, and with sufficient biosafety containment levels. It was also recommended that the ability to determine WNV through autopsy be pursued by select laboratories.

Mosquito control was to focus on source reduction, especially through public education because of the role believed to be played by *Culex pipiens* in the disease transmission. *Culex* mosquitoes prefer to breed in dirty fresh water and do not migrate far; therefore, it may be possible to reduce human infection rates by eliminating preferred habitats near to dwellings and outdoor assembly areas. Water management, including OMWM, was seen as being effective in reducing potential vector populations, especially when biological control elements were emphasized. Larviciding was seen as an integral part of an integrated control program. Aerial adulticiding was to be reserved as a last resort. There was also acknowledgement that resistance management

(management by moderation, management by continued suppression, and management by multiple attack) should be included in determining exactly how to address the vector control problem. Local programs were perceived as likely being more effective than establishing larger, more centralized infrastructures.

CDC identified a need for further training and reevaluations of local health priorities by state health departments to adequately address the disease threat. In addition, a need to establish effective transmission of information without compromising basic privacy rules was acknowledged.

Finally, the report made the case to establish research programs to increase knowledge about some twenty topics, in order to ensure more effective responses as the disease progressed.

2.3 Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA, 1993)

This report was authorized pursuant to Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990. The publication intends to provide guidance regarding certain land use activities to mitigate stormwater impacts, especially to coastal waters. This report also provides an extensive review of nonpoint stormwater control issues and remedial practices to direct state nonpoint pollution control programs. It includes a review of stormwater issues relating to a variety of land use categories and related subtopics to mitigate stormwater pollutant loading. This document is included in this review as it has provided a nationwide framework for managing stormwater, and so has had a significant impact on coastal zone environmental management. Its standards and recommendations are relevant to vector control as they address the management of stormwater, which can result in the creation or elimination of stagnant pools serving as mosquito breeding areas. The use of sumps, retention and detention basins, grassed swales, open stormwater trenches, and other types of control structures are necessary for adequate stormwater control, water quality protection, and the prevention of flooding; however, they can also induce mosquito breeding. It should be noted that addressing the link between stormwater control policies and the creation or elimination of mosquito habitat potentially affects all levels of government, as Federal, state, county, and local agencies are all involved in stormwater control activities through roadwork.

The report contains a section, "Management Measures for Wetlands, Riparian Areas, and Vegetated Treatment Systems," which discusses the functions and benefits of these features, describes vegetated stormwater treatment facilities, and recommends various management practices to protect these areas, specifically from stormwater impacts. This section specifically addresses wetlands and riparian areas. Although this section does not expressly address vector control issues, it discusses stormwater management in areas that are considered prime mosquito breeding areas.

In particular, the report recommends three specific management measures:

- Management Measure for Protection of Wetlands and Riparian Areas: Protect from adverse effects wetlands and riparian areas that are serving a significant [non-point source (NPS)] abatement function and maintain this function while protecting the other existing functions of these wetlands and riparian areas as measured by characteristics such as vegetative composition and cover, hydrology of surface water and ground water, geochemistry of the substrate, and species composition.

- Management Measure for Restoration of Wetland and Riparian Areas: Promote the restoration of the preexisting functions in damaged and destroyed wetlands and riparian systems in areas where the systems will serve significant NPS pollution abatement function.

- Management Measure for Vegetated Treatment Systems: Promote the use of engineered vegetated treatment systems such as constructed wetlands or vegetated filter strips where these systems will serve a significant NPS pollution abatement function.

In addition to the aforementioned which specifically address wetlands and riparian areas, many other sections of the guidance document contain subsections relating to wetlands and riparian areas (i.e., the Forestry section); habitat management (i.e., Marinas and Recreational Boating and Hydromodification sections); and pesticide management (Agriculture section).

2.4 NPS

2.4.1. Mosquitoes and Public Health: Protecting a Resource in the Face of Public Fear (Dillon, 2002)

This report was written by the then-Superintendent of the Fire Island National Seashore (FINS), and included the following passage:

> Mosquitoes and Fire Island: the two are synonymous for the millions of visitors who come to Fire Island National Seashore every year, for the 30,000 people who live within the park, and for the additional hundreds of thousands who live within five miles of the island. When the mosquito-borne West Nile Virus (WNV) arrived in the New York area in 1999, mosquitoes became the object of a whole new sense of danger and fear to the public. The response of the National Park Service (NPS) and Fire Island National Seashore became a critical element in protecting the extensive bay marshes and wetlands in the national seashore while responding to public health concerns.

FINS was established in 1964

> for the purpose of conserving and preserving for the use of future generations certain relatively unspoiled and undeveloped beaches, dunes, and other natural features within Suffolk County, New York, which possess high values to the Nation as examples of unspoiled areas of great natural beauty… (P.L. 88-587)

In that law, NPS is charged to "administer and protect the Fire Island National Seashore with the primary aim of conserving the natural resources located there." In 1980, Congress further established within the national seashore the Otis Pike Fire Island High Dune Wilderness, the only wilderness in the NPS in the northeast US. This gave these lands in the eastern end of the park a protection afforded by the Wilderness Act, in addition to NPS protections. It is in this wilderness that the mosquito populations are highest.

FINS encompasses 26 miles of Fire Island (which is 32-miles in total length). The park also includes more than 20 smaller islands, bay waters, and the detached 612-acre William Floyd Estate. FINS has allowed, and actually supported, marsh restoration activities on the William Floyd Estate that have been classified as OMWM (although they were not undertaken primarily to increase mosquito control, but rather to restore hydrology to pre-ditching conditions).

On the island and within the FINS boundary are 17 communities that host a summer population of 30,000. The management of mosquitoes in the marshes has been a source of discussion and disagreement between the NPS, SCVC, and SCDHS since at least 1976. The discussions centered on nuisance impacts (mosquitoes biting park neighbors, island residents, and visitors) and public health concerns over EEE.

In the early 1980s, residents of the nearby communities of Mastic, Mastic Beach, and Shirley tried to make NPS reverse its policies on mosquito control, mainly due to salt marsh mosquito impacts (believed to be flying across the bay. NPS remained opposed to using pesticides to address this "nuisance issue," but commissioned a study of mosquito dispersion (Ginsberg, 1986), and work by CDC and the US Public Health Service (USPHS) to assess health risks from the mosquitoes found on eastern Fire Island. Ginsberg and the CDC/USPHS studies determined that there was no significant risk of EEE from the mosquitoes on Fire Island, and only a portion of the Fire Island mosquito population migrate to the mainland.

It is the policy of NPS not to use pesticides to control nuisance insects. The agency's management policies state: "Native species will be allowed to function unimpeded except … to manage a human health hazard as defined by the Centers for Disease Control or to protect against a significant threat to public safety" (Chapter 4:13). In addition, mosquito management within the Seashore is specifically addressed in the general management plan for FINS, which states that "the use of insecticides, herbicides and other chemical and petroleum products as widely applied flora and fauna control methods on federally owned tidal marshes and other lands will not be allowed." Use of pesticides in the wilderness was further addressed in the 1983 wilderness management plan for the park: "[T]he routine maintenance of existing ditches and the use of chemical pesticides [including *Bacillus thuringiensis,* or Bti] as mosquito control techniques will not be permitted."

However, SCVC can operate without NPS restrictions in the communities within the national seashore. Although these communities are interspersed with federally owned lands and the waters are connected, NPS has never sought to restrict or manage the use of pesticides in these areas. The general management plan does state that "use of these substances on non-federally-owned lands within the legislated boundary of Fire Island National Seashore will be

discouraged," though there is no history of action on the part of NPS to do so. The legal case *U.S. v. Moore* established the authority of NPS to control the use of pesticides on non-Federal land within a legislated boundary.

Following the discovery of WNV on Long Island in 1999, FINS instituted the programs discussed in more detail below.

2.4.2 How Does the National Park Address Mosquito Populations in its Park Units: Questions and Answers About Mosquitoes and West Nile Virus and Encephalitis (NPS, 2003a).

This pamphlet states that the *Culex* species of mosquito is the primary carrier of WNV and EEE. *Culex* inhabits freshwater areas and remains in close proximity to her source of freshwater. Consequently, relatively few are found at the FINS (or in coastal marsh areas that are removed from freshwater sources). Since 1982, NPS has reportedly tested hundreds of thousands of mosquitoes on Fire Island and has never detected encephalitis. (Editorial note: SCVC notes that WNV has been detected in mosquitoes on Fire Island and the William Floyd Estate, and that in 2000 NPS authorized the use of aerial adulticide applications for a large part of the seashore. This application was not made for operational reasons.)

All NPS areas are working cooperatively with Federal and local mosquito management and health agencies. For instance, at FINS, NPS has worked with CDC, SCVC, and NYSDOH and SCDHS to conduct monitoring and surveillance programs, to allow early detection of any virus-bearing mosquitoes.

The NPS actively manages mosquitoes in its park units. Although generally NPS does not like to alter natural processes in its parks, under certain circumstances, native species including mosquitoes can be controlled when a public health emergency has been declared. Localized applications of larvicides and/or adulticides are allowable, but must be approved by the Director of the NPS. In particular, the 2000 NPS Management Policies state that pests may be controlled "to manage a human health hazard when advised to do so by the Centers for Disease Control or to otherwise protect against a significant threat to human safety." CDC and USPHS have never

found a significant threat to human safety from mosquitoes on Fire Island. (Editorial note: please see above, where NPS requested an aerial application of adulticide in 2000 due to WNV risks.)

NPS policy is that, until there is a health risk declared by the CDC, the application of pesticides may be a greater health threat to the public than the mosquitoes. The NPS takes take a variety of actions to help prevent the spread of disease before there is a health emergency.

NPS recognizes significant environmental roles for mosquitoes. Mosquitoes pollinate flowers, and are prey for a wide range of creatures such as fish, turtles, frogs, birds, and bats. Many insecticides impact non-target species such as butterflies, mites, ladybugs, other pollinators, and decomposers that consume organic materials and detritus.

The NPS recommends that its visitors and employees in areas with mosquitoes do the following:

- Help eliminate temporary mosquito habitat (stagnant fresh water) in flowerpots and buckets, stopped-up rain gutters, discarded cans, etc.
- Learn about mosquito avoidance, by not going into areas of heavy mosquito infestation at dusk and not wearing cologne or perfume which can attract mosquitoes.
- Wear long-sleeved shirts, long pants, a hat, and gloves, which can provide increased protection from mosquitoes.
- The use of an insect repellent, such as a formula using 20 percent to 30 percent DEET (N,N-diethyl-meta-toluamide) as the active ingredient, applied on clothes or sparingly on exposed skin, can decrease bites.

2.4.3 2003 Policies for FINS (NPS, 2003b)

FINS has taken the following actions in managing its mosquito populations:

1. Developed and implemented a mosquito testing and monitoring program throughout FINS.

2. Adopted an accelerated step-by-step response in the event EEE or WNV was discovered in mosquitoes on Fire Island or nearby communities. This procedure includes the use of pesticides on mosquitoes should a disease risk materialize.
3. Hired a seasonal biologist each year since 1999 to implement the monitoring program.
4. Implemented a restoration of the marsh at the William Floyd Estate. This consisted of plugging the mosquito ditches in order to restore a more natural open water marsh. Studies in other areas have shown this program to restore fisheries, bird habitat, and reduce mosquitoes. The project was completed in the fall of 1999 with the cooperation of the US Fish and Wildlife Service (USFWS), Ducks Unlimited, SCVC, NYSDEC, and the US Geological Survey (USGS).
5. Initiated a public education program through the production of a brochure, "Mosquitoes and You." The brochure addresses the life cycle of mosquitoes, health risks, and personal prevention techniques.
6. FINS staff, including the Superintendent and Deputy Superintendent, conducted a series of public meetings on the island and in nearby communities presenting the new program and answering questions about mosquitoes.
7. The NPS has produced letters, a question and answer sheet, and news releases explaining this program and addressing concerns for the protection of both public health and resource health by minimizing the use of pesticides.
8. A page on the FINS website is devoted to mosquito information.
9. Rangers and maintenance staff regularly look for standing pools of stagnant rainwater that have collected in artificial locations and remove them as soon as possible.

FINS has created a monitoring and response protocol (Ginsberg, 2002) (see Appendix A). This involves mosquito testing coupled with a graduated escalation of response based on sampling results. Testing is done by the same laboratory as all other County samples in order to coordinate findings with SCVC and ensure that the State and County public health officials receive first notice of any evidence of disease. FINS also collects dead birds for testing.

If WNV or EEE were to be detected, the NPS will determine appropriate actions in consultation with other experts. Interventions might include closing portions of the FINS to the public, mosquito management methods such as applications of *Bacillus thuringiensis israelensis* (*Bti*) to

prevent emergences, or adulticide applications to areas with high levels of adult *Culex* or *Ochlerotatus sollicitans* (salt marsh mosquito). As a result of the positive test for WNV found at Saltaire reported on September 7, 2000, from mosquitoes collected between August 22 and 24, 2000, NPS did approve SCVC to use adulticides west of Sailors Haven/Sunken Forest. At that time, SCVC did not find such an application to be required (but note that SCVC did apply adulticides in many communities on Fire Island for control of "nuisance" mosquitoes).

2.5 USFWS

2.5.1 Guidance for Meeting US Fish and Wildlife Service Trust Resource Needs When Conducting Coastal Marsh Management for Mosquito Control on Region 5 National Wildlife Refuges (Taylor, 1998)

The USFWS has produced detailed guidance for Region 5 (the Northeast US) regarding exactly how wetlands in National Wildlife Refuges should be managed. The guidance, which does not address chemical controls, recognizes that mosquito control in the Refuges may be considered to be necessary. It discusses the permissible means of altering existing wetlands to assist in mosquito management.

No alterations of unditched wetlands are allowable. Taylor notes that unditched wetlands in the Northeast US are relatively rare (believed to be less than 10 percent of all remaining salt marshes), and so constitute an important ecological niche. In addition, anthropogenic changes of wetlands are thought to be necessarily damaging to the natural ecology of the wetlands, and so altering an unimpacted wetland is by definition a deleterious action. This policy was established in the 1960s, and codified in 1989 ("only drained or filled marshes may be manipulated," according to the USFWS "Guidance for Physically Altering Wetlands for Fish and Wildlife Management").

Grid ditching is not to be allowed, either. Grid ditching, because it alters the hydrology of the marsh and reduces standing water, negatively impacts preferred waterfowl environments. Two of the primary charges for the Wildlife Refuge system ("to perpetuate the migratory bird resource" and "to preserve a natural diversity and abundance of flora and fauna on refuge lands") are thought to have been compromised by grid-ditching salt marshes.

OMWM is cited a preferential means of managing wetlands to control mosquitoes. Closed ditch systems are identified as being better to implement than sill ditches, and especially as compared to open ditches. Open ditches are thought to be little different than grid ditching in terms of potential impacts on marsh vegetation and waterfowl habitat.

Ponds, especially larger ponds with gently sloping sides to encourage submerged aquatic vegetation and to provide waterfowl and wading birds with preferred habitats, should be installed. Radial ditches do not have the same degree of approval, but are recognized as necessary for effective mosquito control. Specific design criteria are presented for these "appendages" to the ditch plugs needed for OMWM initiation.

The document also presents monitoring requirements for proposed projects, and identifies USFWS Region 5 resources available to assist in project monitoring and oversight.

2.5.2 Concerns and Issues about Mosquito Control on National Wildlife Refuges in the Northeast (USFWS, 1999)

This document was written specifically to address the renewal of Working Agreements in regard to mosquito control between USFWS and the States of New Jersey and Delaware in 2000. However, it also allowed USFWS to establish general guidelines for the northeast US Refuges to follow in order to coordinate mosquito control needs (in the face of WNV) with USFWS missions.

Three major goals were defined:

1) To maintain a system of national wildlife refuges in Delaware and New Jersey where education and non-chemical mosquito control methods have reduced or eliminated the need for pesticide use during periods other than Declared Health Emergencies.
2) Mosquito control is allowed on NWRs in a manner which protects fish and wildlife and does not interfere with plant and wildlife management activities.
3) Relationships between the Service, States, and mosquito control agencies are open, active and flexible, resulting in the ability to address and resolve new and ongoing issues.

Specific objectives relating to each goal were also enumerated.

Eighteen issues were also identified as impacting mosquito control at the refuges. For example, 1997 legislation (the Refuge Improvement Act) said that activities that may adversely impact wildlife populations or habitats must be modified, but also that human health threats take precedence over wildlife concerns. Most of the other issues can be interpreted as specific examples of balancing these two, sometimes conflicting ideals. For example, because research cited in the report found non-target impacts to invertebrates and "Declared Health Emergencies" was not considered to be a well-defined term, many of the issues discussed minimizing mosquito control (especially with chemicals) and educating people so as to minimize "nuisance" and non-Health Emergency concerns about mosquitoes. Although IPM was recommended, some concerns about the long-term impact of OMWM were discussed, and the effectiveness and need for adulticiding was questioned. In summation, OMWM was banned from use in wilderness areas of the refuges and some specific adulticides (some in all applications and others in specific environmental settings) and the use of slow-release larvicides were recommended to be banned. However, greater efforts for communication between program managers and refuge managers were also recommended to ensure that site- and situation-specific plans could be formulated.

3 New York State

3.1 Environmental Laws, Rules and Regulations Relating To Mosquito Control in New York State – Pesticide Use, Habitat Modification, Fish Stocking and Wildlife Collection (NYSDEC, 2000)

This document, prepared by NYSDEC with input provided from its Pesticide Work Group, is one of the more comprehensive documents on laws relating to mosquito control, the use of mosquitocides, and wetlands management. The purpose of the guidance manual is to develop a standard State framework for ensuring that environmental laws and policies are followed during the implementation of mosquito control programs.

This report was generated in response to the discovery of WNV in New York in 1999, anticipating increased mosquito control activities. The report is aimed not only at municipal mosquito control efforts, but also is intended to address the needs of registered pesticide applicators and even individual property owners, and to address mosquito control in general (not just control intended to address WNV problems).

Part 1 of the Task Report (separate cover) will discuss this document more completely. However, two points should be noted in connection with the document:

- In the discussion of Freshwater Wetlands permits, it is noted that NYSDEC's interpretation of the regulations creates a hierarchy for mosquito control where a comprehensive larviciding program is the preferred methodology for mosquito control in freshwater wetlands, over adulticiding and habitat modification. In fact, habitat modification is to be approved only as "a last resort."
- In the discussion of Tidal Wetlands Permits, it is noted that "[p]oorly designed, constructed, or maintained mosquito ditching" is so detrimental to wetlands that it is "equivalent of dredging or filling the marsh." Ditching activities are restricted to governmental agencies only, therefore. It is also noted that "the Department strongly encourages the use of Open marsh Water Management (OMWM) principles when creating or maintaining mosquito ditches. These principles include techniques such as using ditch plugs to more effectively control mosquito populations while minimizing adverse impacts on the hydrology and values of the marsh."

3.2 New York State West Nile Virus Response Plan (NYSDOH, 2001)

This report focuses on WNV, and recommends the use of IMM. It endorses an Integrated Mosquito Management (IMM) approach. In particular, emphases are made on the needs for public education, surveillance of mosquito populations and virus receptors including birds, mammals, and humans, and virus prevention and management. The plan promotes mosquito population reduction, management of breeding locations, interagency coordination, and dissemination of information to the public.

In particular, the plan sets out to describe:

- The prevention, response, and control systems that will be implemented
- The surveillance systems to identify the virus in mosquitoes
- The surveillance systems to identify the virus in birds and mammals
- The improved data systems for electronic data collection and sharing among public health agencies, and,
- The campaign to heighten public awareness about reduction of *Culex pipiens* breeding sites and personal mosquito protection

Responses to disease threats are to be based on a tiered hierarchical approach, where the response taken would have an increased potential for collateral human health or environmental impacts as the perceived human health threat from WNV increased. Table 2-1 presents these tiers.

NYSDOH specifically notes with regard to aerial applications to control adult mosquitoes:

> In general, ground application of pesticides should be the preferred method of control. Aerial applications of insecticides for adult mosquito control should be carefully considered only in Tier IV circumstances and only after taking into account multiple factors, including the size of the vector population, the vectors' physiologic age, the density and proximity of human populations, the time of year, weather conditions, physiography and accessibility to the area where the vector is located, rapidity of response required as determined by the seriousness of the health threat, and the likelihood that vectors in nearby areas not subject to control measures will migrate from the area if not subject to control. Aerial spraying should be limited to the immediate area where the vector population has been documented to exist through vector surveillance and to adjacent areas considered at risk for imminent disease transmission.

The Department of Health sees a general need for local Health Units to conduct environmental assessments to define environmental conditions that may be present in the area that support mosquito populations. The assessment would focus on *C. pipiens* breeding opportunities for surveillance for immature mosquitoes (natural or man-made wetlands, abandoned swimming pools, etc.) but would also include identification of environmentally-sensitive areas and areas to be excluded from chemically-based mosquito control.

The disease risk assessment would include the likelihood of exposure to *C. pipiens* and to areas where virus has either been documented or that might support large populations of *Culex* mosquitoes (without any intervention steps).

The plan identifies how to interpret surveillance data, and allocated, based on 1999 experience, testing resources in the NYSDOH laboratory (although bird testing resources were to be allocated on the basis of "temporal and geographic patterns" occurring in the next outbreak). The report also identified chickens as an appropriate sentinel species (this has proven not to be the case, however). Specific surveillance advice was generated based on perceived risks for disease reoccurrence (more active surveillance was suggested for those areas with a history of WNV). Procedures were established to ensure that data were transmitted to the proper agencies in a timely fashion.

The plan identified many concrete steps to be taken to educate the public and the health care provider community. Generally, public education was to focus on mosquito avoidance (including habitat minimization around homes and businesses), and the health care outreach was to center on case recognition and treatment. The outreach efforts were to be varied depending on the virus situation and time of year. Specific recommendations were also created for governments to minimize mosquito habitat under their control.

The report also provides specific suggestions regarding the use of insecticides to control mosquitoes. It provides counsel regarding legal obligations of the local Health Units. It also specifies actions that NYSDOH and NYSDEC will undertake to address some pressing needs of local governments, including appropriate training and outreach.

Appendices to the report included the Decision Matrix, a great deal of information regarding pesticides and their potential effects on people and the environment, a copy of the latest compilation of appropriate rules, regulations, and laws (see Section 2.3.1, above), along with other technical documents useful in mosquito control and WNV responses.

3.3 New York State Department of State Coastal Zone Management Program State Coastal Policies

3.3.1 Federal Consistency

The consistency provisions of the Federal Coastal Zone Management Act of 1972 require Federal agency activities to be consistent with the state's federally approved Coastal Management Program. This requirement applies to all Federal actions and federally authorized activities which affect the state's coastal zone. Applicants for Federal agency approvals or authorizations are required to submit copies of Federal applications to the New York State Department of State (NYSDOS), together with a Federal Consistency Assessment Form and consistency certification; so that the Department can review the consistency certification and proposal for consistency with the Coastal Management Program. Applicants for Federal funding must submit an identification of the proposed funding source and a description of the project. If the NYSDOS determines that the proposed activity would be inconsistent with the state's Coastal Management Program, Federal agencies may not fund or approve the proposal. Direct activities by Federal agencies are subject to similar requirements.

Therefore, any mosquito control activities supported by Federal funding or undertaken in cooperation with Federal agencies, must be reviewed by NYSDOS for consistency with the State Coastal Management Program.

3.3.2 State Consistency

No state agency involved in a Type I or unlisted action (under the definitions of SEQRA) may carry out, fund, or approve the action until the agency has complied with the provisions of Article 42 of the New York State Executive Law and implementing regulations in 19 NYCRR Part 600. The law and regulations require certain state agency actions in the coastal area to be consistent with the coastal policies in 19 NYCRR Part 600.5, or a state-approved Local Waterfront Revitalization Program (LWRP). Type I and unlisted actions are required to be

evaluated for possible effects on coastal policies or approved LWRPs. As soon as an agency determines its action is being contemplated in the coastal area, and prior to making a determination of significance pursuant to SEQRA, the agency must complete a Coastal Assessment Form (CAF) to assist it in making determinations of coastal consistency and environmental significance. For state agency actions involving an EIS, the EIS must include an identification of the applicable coastal policies and a description of the effects of the action on those policies, whether the agency is acting as the lead or the involved agency. State agencies may not make a final decision on the action until the state agency has made a written finding that it is consistent with the coastal policies in 19 NYCRR Part 600.5 or an approved LWRP.

The following State coastal policies either address issues related to vector control or have some relevance as they relate to the management of wetland environments such as the implementation of OMWM techniques, and the application of mosquitocides. In approaching the selection of potentially relevant policies, we have chosen to be more liberal than constructivist.

3.3.2.1 Fish and Wildlife Policies (NYSDOS, 2001)

Policy 7: Significant Coastal Fish and Wildlife Habitats will be protected, preserved, and where practical, restored so as to maintain their viability as habitats.

Habitat protection is recognized as fundamental to assuring the survival of fish and wildlife populations. Certain habitats are particularly critical to the maintenance of a given population and, therefore, merit special protection. Such habitats exhibit one or more of the following characteristics:

(a) are essential to the survival of a large portion of a particular fish or wildlife population (e.g. feeding grounds, nursery areas);
(b) support populations of rare and endangered species;
(c) are found at a very low frequency within a coastal region;
(d) support fish and wildlife populations having significant commercial and/or recreational value; and
(e) would be difficult or impossible to replace.

In order to protect and preserve a significant habitat, land and water uses or development shall not be undertaken if such actions destroy or significantly impair the viability of an area as a habitat. When the action significantly reduces a vital resource (e.g., food, shelter, living space) or changes environmental conditions (e.g., temperature, substrate, salinity) beyond the tolerance range of an organism, then the action would be considered to "significantly impair" the habitat. Indicators of a significantly impaired habitat may include:

- reduced carrying capacity
- changes in community structure (food chain relationships, species diversity)
- reduced productivity
- increased incidence of disease and mortality.

The range of generic activities most likely to affect significant coastal fish and wildlife habitats include, but are not limited to the following:

1. Draining wetlands and ponds, which may cause changes in vegetation, or changes in groundwater and surface water hydrology.
2. Filling wetlands, shallow areas of streams, lakes, bays, or estuaries, which may change the physical character of substrate (e.g., sandy to muddy, or smother vegetation, alter surface water hydrology).
3. Grading land, which may result in vegetation removal, increased surface runoff, or increased soil erosion and downstream sedimentation.
4. Clear cutting, which may cause loss of vegetative cover, increase fluctuations in amount of surface runoff, or increase streambed scouring, soil erosion, sediment deposition.
5. Dredging or excavation, which may cause change in substrate composition, possible release of contaminants otherwise stored in sediments, removal of aquatic vegetation, or change circulation patterns and sediment transport mechanisms.
6. Dredge spoil disposal, which may include shoaling of littoral areas, or change circulation patterns.
7. Physical alteration of shore areas through channelization or construction of shore structures, which may change the volume and/or rate of flow, or increase scouring, and/or change sedimentation patterns.
8. Introduction, storage or disposal of pollutants such as chemical, petrochemical, solid wastes, nuclear wastes, toxic material, pesticide, sewage effluent, urban and rural runoff,

leachate of hazardous and toxic substances stored in landfills, which may cause increased mortality or sublethal effects on organisms, alter their reproductive capabilities, or reduce their value as food organisms.

The range of physical, biological and chemical parameters which should be considered include, but are not limited to, the following:

1. Physical parameters, such as living space, circulation, flushing rates, tidal amplitude, turbidity, water temperature, depth (including loss of littoral zone), morphology, substrate type, vegetation, structure, erosion and sedimentation rates;
2. Biological parameters, such as community structure, food chain relationships, species diversity, predator/prey relationships, population size, mortality rates, reproductive rates, behavioral patterns and migratory patterns; and,
3. Chemical parameters, such as dissolved oxygen, carbon dioxide, acidity, dissolved solids, nutrients, organics, salinity, and pollutants (heavy metals, toxic and hazardous materials).

When a proposed action is likely to alter any of the biological, physical or chemical parameters beyond the tolerance range of the organisms occupying the habitat, the viability of that habitat has been significantly impaired or destroyed. Such an action, therefore, would be inconsistent with this policy. In cooperation with the State's Coastal Management Program, NYSDEC developed a rating system incorporating these five parameters (1981). To further aid Federal and State agencies in determining the consistency of a proposed action with this policy, a narrative needs to be prepared for each significant habitat which:

(1) identifies the location of the habitat;

(2) describes the community of organisms which utilize the habitat;

(3) identifies the biological, physical and chemical parameters which should be considered when assessing the potential impacts of a project on that habitat;

(4) identifies generic activities which would most likely create significant impacts on the habitat; and,

(5) provides the quantitative basis used to rate the habitat.

Prior to formal designation of significant fish and wildlife habitats, copies of the individual habitat narratives plus copies of habitat maps and completed rating forms will be provided to Federal and State agencies and the public for the review and comment.

Policy 8: Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants which bio-accumulate in the food chain or which cause significant sublethal or lethal effect on those resources.

Hazardous waste is defined in Environmental Conservation Law [S27-0901(3)] as "waste or combination of wastes which because of its quantity, concentration, or physical, chemical or infectious characteristics may:

(1) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or,

(2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or otherwise managed."

A list of hazardous wastes (NYCRR Part 366) will be adopted by DEC within 6 months after EPA formally adopts its list.

The handling (storage, transport, treatment and disposal) of the materials included on this list is regulated in New York State to prevent their entry or introduction into the environment, particularly into the State's air, land and waters. Such controls should effectively minimize possible contamination of and bio-accumulation in the State's coastal fish and wildlife resources at levels that cause mortality or create physiological and behavioral disorders. Other pollutants are those conventional wastes generated from point and non-point sources, and not identified as hazardous wastes, but controlled through other State laws.

Although the above does not expressly state a concern over pesticides, it is apparent that the application of pesticides that might not be appropriate in environmentally sensitive coastal areas might be considered to be "other pollutants" in so far as the potential adverse effects that could ensue.

3.3.2.2 Water and Air Resources Policies (NYSDOS, 2001)

Policy 30: Municipal, industrial, and commercial discharge of pollutants, including but not limited to, toxic and hazardous substances, into coastal waters will conform to state and national water quality standards.

Municipal, industrial and commercial discharges include not only "end-of-the pipe" discharges into surface and groundwater but also plant site runoff, leaching, spillages, sludge and other waste disposal, and drainage from raw material storage sites. Also, the regulated industrial discharges are both those which directly empty into receiving coastal waters and those which pass through the municipal treatment systems before reaching the State's waterways.

Although this policy has no direct link to pesticide use, it is concerned with the potential contamination of environmentally and ecologically sensitive areas from the release of materials which may be toxic or otherwise hazardous to these systems.

Policy 33: Best management practices will be used to ensure the control of stormwater runoff and combined sewer overflows draining into coastal waters.

Best management practices include both structural and non-structural methods of preventing or mitigating pollution caused by the discharge of stormwater runoff and combined sewer overflows. Many of these approaches, however, may cause increases in the areas mosquitoes breed, or promote greater rates of mosquito breeding (ref.). In addition, criticisms of traditional water management through the use of mosquito ditches in salt marshes have included the idea that they serve as conduits for stormwater flow through a wetland, as opposed to being treated in the wetland.

Policy 38: The quality and quantity of surface water and groundwater supplies, will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply.

Surface and groundwater are the principal sources of drinking water in the State, and therefore,

must be protected. Since Long Island's groundwater supply has been designated a "sole source aquifer," all actions must be reviewed relative to their impacts on Long Island's groundwater aquifers.

This policy is obviously designed to promote the preservation of water resources. Although this policy is quite general in nature, it strives to ensure that all activities which have the potential to degrade ground and surface waters be carefully considered, particularly where the water is used as a source of potable drinking water.

Policy 44: Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.

Tidal wetlands include the following ecological zones:

- coastal fresh marsh
- intertidal marsh
- coastal shoals
- bars and flats
- littoral zone
- high marsh or salt meadow
- formerly connected tidal wetlands.

These tidal wetland areas are officially delineated on the NYSDEC Tidal Wetlands Inventory Map. Freshwater wetlands include marshes, swamps, bogs, and flats supporting aquatic and semiaquatic vegetation and other wetlands so defined in the New York State (NYS) Freshwater Wetlands Act and NYS Protection of Waters Act.

The benefits usually associated with the preservation of tidal and freshwater wetlands include but are not limited to:

- habitat for wildlife and fish, including a substantial portion of the State's commercial fin and shellfish varieties;
- contribution to associated aquatic food chains;
- erosion, flood and storm control;

- natural pollution treatment;
- groundwater protection;
- recreational opportunities;
- educational and scientific opportunities; and
- aesthetic open space in many otherwise densely developed areas.

Therefore, any water management activities must be conducted so as to preserve the wetlands themselves, and also to ensure there are no losses in functions associated with the wetland.

3.4 Identification of Reference Wetlands on Long Island, New York (MacDonald and Edinger, 2000)

The New York Natural Heritage Program enables and enhances conservation of New York's rare animals, rare plants, and significant ecosystems. They combine thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resources planning, protection, and management. This resource is most commonly used to determine the presence or absence of rare, endangered, and threatened species within particular areas of the State.

The Program works under an ecological classification approach. The original definition of New York State ecological communities was created by Reschke (1990) and updated in 2002 (Edinger et al.). There are twelve wetland community types. Ten of these were identified on Long Island in the comprehensive review of Long Island's wetlands by MacDonald and Edinger (2000).

For each of the ten ecological communities, reference sites were selected. The selection of reference sites was also affected by the use of four marine physiographic zones (based on estuary, with Long Island Sound being divided into two tidal ranges) and seven palustrine physiographic settings (based on the morainal classification of Sirkin [1982]). This resulted in 30 reference communities (at 20 different sites – some sites serve as reference communities for one than one ecological community) being selected. In the report, each reference community received a specific description, including broad management proposals.

3.5 New York State Salt Marsh Restoration and Monitoring Guidelines (Niedowski 2000)

This report prepared for NYSDOS and NYSDEC provides guidance for the restoration and monitoring of voluntary salt marsh restoration projects. It was written to provide technical guidance in support of State environmental restoration funding opportunities available through the 1996 Clean Water/Clean Air Bond Act and the Environmental Protection Fund. It had been noted that many restoration projects suffer from poor planning, lack of baseline site data, post-project impact determination, collection of uncomparable information, and a general lack of a determination of project success or failure. The intent of the document was to address these problems by establishing a generalized means of collecting information in relation to a salt marsh restoration. The report is intended to both educate the neophyte and to provide pertinent guidance to those implementing a restoration.

The report provides a good primer on salt marsh ecology, structural characteristics, and functions. It defines the restoration efforts in terms of attaining functions at a particular site. The goal of monitoring is thus to measure the proper functional attributes to determine success or failure of the project (although function may be inferred from structural attributes that may be easier to measure). The report identifies hydrological changes as the key element that can result in profound impacts to marsh functions.

Disturbances of salt marshes are identified as being caused by people or natural events. The human causes of salt marsh degradation are:

- ditching
- filling
- restrictions of tidal connections
- installing dikes and/or impoundments
- pollution (spills, DDT use, stormwater discharges)
- shoreline hardening (installation of structures)
- sea level rise caused by global warming

Natural causes of marsh impacts include:

- seasonal disturbances (ice, debris rafting)

- disasters (hurricanes, nor'easters)

Impacts from these events (especially the anthrpopogenic events) were identified as:

- changes in the tidal regime
- marsh surface subsidence
- flooding
- salinity changes
- vegetation changes

Restoration can be intended to undo these impacts. Specific considerations involved in manipulating these factors were given.

In the course of this guidance, OMWM was discussed as a desirable means of mosquito control. Taylor (see Section 2.2.4.1) was used as the authoritative expert, and so closed systems and "semi-tidal" (sill) systems were identified as the better means of implementation. Drawbacks to OMWM (on-going maintenance requirements and proper spoil management) were mentioned but dismissed as manageable through proper implementation. *Phragmites* control also receives some attention (*Phragmites* are identified as causing increased mosquito breeding – but the claim is not referenced).

Extensive guidance for monitoring of project implementations are made. These include recommendations for pre-monitoring, post-monitoring, and five-year anniversary monitoring events.

Extensive bibliographies and supporting documentation in appendices are provided.

4 Regional Planning Initiatives

These efforts include the three estuary programs (SSER, LISS, and PEP) as well as the Special Groundwater Protection Areas (SGPA) Plan and the Central Pine Barrens Comprehensive Plan. In addition, the Long Island Wetland Restoration Initiative is a regional organization that intended to be involved in wetlands restoration and associated mosquito control activities.

4.1 Long Island SSER CCMP (Long Island SSER Council, 2001)

This report summarizes the findings of a seven-year process intended to protect and prudently manage the South Shore bays and associated uplands of Long Island, in both Nassau and Suffolk Counties. The following items appear to be pertinent to mosquito and wetlands management.

4.1.1 Chapter 2 Improve and Maintain Water Quality

Recommendation #4: Implement priority stormwater remediation projects in significant nonpoint source contributing areas identified in individual municipal watershed plans.

As discussed above, stormwater management can have impacts on mosquito breeding areas and numbers. In addition, water management techniques used for vector control purposes may impact stormwater flows through wetlands.

Recommendation #8: Institute appropriate best management practices to reduce the contamination of stormwater runoff by hazardous materials, fertilizers, herbicides and pesticides, household hazardous wastes, and wildlife and pet wastes.

Runoff containing larvicides and/or adulticides may have potential negative impacts on aquatic species.

Recommendation #11: Adopt best management practices to restore and create wetlands.
Recommendation #12: Adopt best management practices to protect wetlands and streams.

These two recommendations could impact the use of water management for mosquito control. It is not clear whether these recommendations are supportive of various water management techniques (e.g., traditional ditch maintenance or OMWM) or not.

4.1.2 Chapter 3 Protect and Restore Living Resources of the Reserve

Recommendation #2: Document the current status of living resources in the Reserve and implement a comprehensive ecosystem monitoring program to document and evaluate improvements in quality and quantity of living resources achieved through restoration and other management measures.

Recommendation #4: Improve the ecological function and productivity of the estuary by increasing the quality and quantity of its wetlands.

Recommendation #9: Support productivity of commercially and ecologically important estuarine species by sustaining existing habitats of high functional quality and restoring degraded habitats, particularly submerged aquatic vegetation (SAV) beds and shallows.

Recommendation #11: Evaluate the conditions and needs for rehabilitation of palustrine forested wetlands associated with the Reserve's tributary corridors and the tidal wetlands that play an important role in the ecology of the Reserve's bay bottoms and barrier islands.

Each of these recommendations could impact the use of water management for mosquito control. It is not clear whether these recommendations are supportive of various water management techniques (e.g., traditional ditch maintenance or Open Marsh Water Management [OMWM]) or not.

4.1.3 Chapter 6 Increase Education, Outreach, and Stewardship

Recommendation #13: Collaborate with traditional mass media outlets, as well as government and private sector information outlets, to run stories and carry information on a regular basis about the estuary.

Recommendation #16: Develop and distribute one page fact sheets on geology, oceanography, estuarine species and topics and issues pertinent to the Reserve.

These could be used as means of improving education regarding mosquito management.

4.1.4 Chapter 7 Implementation

Implementation Action 4-1 Restoration of tidal wetlands**:** Human activities related to development, agriculture and navigation have resulted in a significant historical loss or degradation of the Reserve's tidal wetlands. Additional marsh losses from erosion, particularly of marsh islands, have also been substantial and require further investigation (see Action 6-12). Loss of tidal wetlands has meant a reduction in the ability of these habitats to stabilize sediments, mitigate storm impacts, provide habitat for fish and shellfish, waterfowl and colonial waterbirds, and remove water-borne nutrients and contaminants. Within the Reserve, there are approximately 19,000 acres of tidal wetlands, most of which have been altered by mosquito ditching practices, dredged material placement, and restriction of tidal flow. The complete extent of potential restoration will require further evaluation (see Action 6-10). Noteworthy restoration has already been completed by the towns of Babylon (Ketcham's Creek and Santapogue Creek corridors), Hempstead (Norman J. Levy Park) and Southampton (Ponquogue Bridge area), and there are restoration projects currently underway in the Town of Brookhaven in the Mastic Beach area. Within the context of a coordinated Reserve-wide plan, all towns need to develop local tidal wetland restoration programs.

In cooperation with various partners, application of the NYSDOS's wetland restoration assessment tool has provided guidance for an initial list of wetland sites appropriate for restoration activity (see example at end of chapter) with an initial focus on wetland sites degraded through deposition of dredge material or restricted tidal flow. The Long Island Wetlands Restoration Initiative, a formal cooperative effort between the NYSDEC, the U.S. Fish and Wildlife Service, Suffolk County's Division of Vector Control, and Ducks Unlimited has selected wetland restoration sites in the Reserve. These are large sites requiring restoration of natural tidal flow patterns through closure of mosquito ditches. The U.S. Army Corps of Engineers, as part of its South Shore of Long Island Environmental Restoration Study, has identified a number of restoration candidate sites: Meadow Island, West Meadow Island, Pearsall's Hassock and Alder Island (Hempstead); Ox Island/Nazeras Island, North Gilgo and Indian Island County Park (Babylon); Northeast Captree Island/Sand Island and Brown's River (Islip); and Island Point Marsh (Brookhaven). These are primarily large sites requiring removal of dredged material

deposits. A list of initial project sites is being developed for the Town of Islip using the assessment tool. *Responsibility:* NYSDOS, NYSDEC, and NYSDOT, NYS Office of Parks, Recreation, and Historic Preservation, counties, towns, Long Island Wetlands Restoration Initiative.

This recommendation explicitly identifies grid-ditched marshes as requiring restoration, and identifies particular features of the wetlands (sediment stabilization, storm protection, provision of habitat, nutrient and contaminant removal) as the attributes that result from wetlands. Presumably, wetland management that is not ditch maintenance and that enhances these processes would support this planning goal.

There are no other direct references to mosquito control activities. The plan contains many recommendations to improve stormwater problems, protect fish and wildlife, maintain vital habitat, preserve wetlands and surface waters, and provide public outreach and education, and some of these may be inferred as referring to wetlands and/or mosquito management practices. The most pertinent of these are listed:

Implementation Action 1-1: Construction of stormwater abatement projects in significant nonpoint source contributing areas associated with closed shellfish beds, impaired living resources, and bathing beaches that experience periodic closures due to water quality concerns.

Implementation Action 1-2, Section 3: Reduction of fertilizer, herbicide and pesticide use

Implementation Action 4-2: Coordination of wetland restoration efforts

Implementation Action 4-4: Habitat restoration in tributaries

Implementation Action 11-2: Supporting efforts to improve water quality, living resource protection, and restoration actions.

4.2 LISS

According to the LISS CCMP Summary (LISS, 1994),

> [t]he plan characterizes the priority problems affecting Long Island and identifies specific commitments and recommendations for actions to improve water quality, protect habitat and living resources, educate and involve the public, improve the long-term

understanding of how to manage the Sound, monitor progress, and redirect management efforts."

The plan identifies six categories of concern including:

1) low dissolved oxygen (hypoxia),
2) toxic contamination,
3) pathogen contamination,
4) floatable debris,
5) the impact of these water quality problems, and habitat degradation and loss, on the health of living resources, and,
6) land use and development resulting in habitat loss and degradation of water quality.

The use of pesticides within the Sound watershed is to be minimized to support toxics reduction. LISS is also supporting research into the die-off of lobsters that began in 1999[3]. Most scientists believe that the adulticiding to address the initial WNV outbreak was coincidental with this die-off, or that the pesticides at most compounded existing lobster problems. However, New York City has been sued by lobstermen organizations as having caused the die-off due to adulticide applications that then reached the Sound (either through aerosol drift or runoff). LISS has not yet taken a formal position on this issue.

The LISS CCMP Tracking Reports (1998, 1999, and 2000) note that the State of Connecticut has replaced its mosquito ditching maintenance practices with OMWM and that New York State has been phasing out its ditching practices. They recommend that New York State continue to phase out mosquito ditching and implement OMWM to control mosquitoes and improve the value of wetlands by restoring wetland ponds and pools.

In 2003, LISS released the *Technical Support for Coastal Habitat Restoration*. This document is intended to serve as technical guidance in achieving the habitat restoration goals of LISS, and of its Habitat Restoration Initiative especially. Twelve habitat types have been identified, and five

[3] The Long Island Sound Lobster Research Initiative, which is carrying out the research to determine the cause of the lobster die-off, is a collaboration among the National Oceanic and Atmospheric Administration, the National Marine Fisheries Service, the Sea Grant programs of Connecticut and New York, USEPA, the Connecticut Department of Environmental Protection Long Island Sound Research Fund, and Atlantic States Marine Fisheries Commission. In 2000, the US Congress appropriated $6.9 million, and Connecticut made $1 million from its Long Island Sound Research Fund available. The final reports from this funded research will be presented at the University of Stony Brook in October, 2004.

were included in this volume (others will be addressed later). One of the habitats specifically addressed was tidal wetlands.

The report discusses each habitat in general, including its values and functions, and Long Island Sound area status and trends. Tidal marshes on Long Island are not as well characterized as they are in Connecticut, in terms of LISS interests (Long Island wetlands tend not to be distinguished by the estuary they front, but through political jurisdictions). Nonetheless, it is clear that Long Island Sound wetlands have decreased in area, and that the marshes that remain are often degraded in quality.

The guidance identifies seven specific impacts on marshes:

- grid (parallel)-ditching
- draining
- impoundments
- filling/burying
- phragmites invasion
- stormwater impacts
- sea level rise impacts

For each impact, preferred means of restoration are cited. For ditched marshes, the restoration methods are given as:

- reversion
- ditch plugs
- pond creation

OMWM, per se, is not identified as a restoration means. While mosquito management is listed as a reason for ditching, mosquito management is not listed as a concern in these restoration plans. In fact, Long Island topography is noted as a reason that its Long Island Sound marshes were not ditched, as the nearness of the moraines to the shore meant there was separation between mosquito habitat and human habitation.

No Suffolk County marsh appears to be on the primary priority list for restoration.

4.3 PEP CCMP (SCDHS Office of Ecology, 2002)

This Plan established seven specific goals toward conserving and managing the Peconic Estuary system:

- Ensure a healthy and diverse marine community; optimizing opportunities for water dependent recreation.
- Promote the social and economic benefits, which have been associated with the Peconic Estuary System.
- Establish a comprehensive water quality policy, which ensures the integrity of marine resources, habitat, and terrestrial ecosystems while supporting human activities in the Peconic Estuary study area.
- Ensure an effective technical, regulatory, and administrative framework for the continued monitoring and management of the Peconic Estuary study area.
- Achieve zero discharge (from point and non-point sources) of toxic pollutants, and particularly of bioaccumulative chemicals.
- Promote an understanding and, appreciation of the value of the Peconic Estuary as an ecosystem and as a mainstay to the East End economy so that it is preserved and restored as one of the last great places in the Western Hemisphere.
- Involve the many and diverse stakeholders in the Peconic Watershed regarding the implementation of the CCMP and in future direction and decisions affecting the estuary.

The Plan is also divided into several management plans:

- Brown Tide Management Plan
- Nutrients Management Pan
- Habitat and Living Resources Management
- Pathogens Management Plan
- Toxics Management Plan
- A Critical Lands Protection Strategy
- Public Education and Outreach Management Plan
- Post CCMP Management

The Plan is replete with brief comments or short discussions regarding mosquito control. These passages include statements regarding previous mosquito ditching practices, Open Marsh Water Management (OMWM), and the general use of pesticides.

The CCMP raises concerns over habitat loss, fragmentation, and degradation by various physical alterations including, but not limited to, the mosquito ditching of marshlands. Another activity given emphasis in the plan is the impacts of pesticides and other chemicals on wildlife. One example involves the osprey which was once severely affected by the widespread application of the pesticide DDT, but the concerns extend to other chemicals in fish tissue, shellfish, and other wildlife, and impacts to vegetation such as eelgrass.

For example:

POE-5: Develop New, and Continue or Expand Existing Education and Outreach Efforts Related to Toxics in the Estuarine System.

POE-5.1: Develop and carry out an education campaign to eliminate or reduce domestic pesticide use in the watershed. Educate home and business owners about the importance of dealing only with certified commercial applicators of pesticides.

POE-5.2: "Increase awareness of the provisions of the State's Freshwater Wetlands Law to reduce or eliminate loadings of pesticides and herbicides on or in the vicinity of wetlands and associated waterbodies."

The Plan contains a number of recommendations for protecting and managing Critical Natural Resource Areas (CNRAs) including limiting pesticide use in these vital areas and establishing marine CNRAs.

Dredging, placement of structures, stormwater discharges, land uses, are noted as a concern by the plan as the removal of spoil, erosion, sedimentation, and stormwater discharge in coastal areas and marshlands can have adverse impacts to wildlife and wildlife habitat.

For example:

HLR-5: Implement, Enforce, and Encourage the Continuation of Current Policies and Regulations Protective of Wetlands.

The plan recommends that the existing wetlands regulation of the State and US Army Corps of Engineers stay in place and in full force.

The CCMP recommends improved coordination between the SCDHS, SCVC, other agencies and departments, and municipalities in maintaining existing mosquito ditches and developing coordinated planning efforts relating to mosquito control in wetlands. The Plan recommends that OMWM techniques be employed. OMWM helps to ensure that fish life that feed on mosquito larvae can survive and be present in areas where mosquitoes breed.

HLR-5.3: Maintain and enforce the policy of creating no new mosquito ditches in tidal wetlands and establish a policy for not re-opening ditches that have filled-in by natural processes.

HLR-5.4: Ensure that SCVC works cooperatively with all government agencies, East End towns and local conservation organizations in planning of wetland mosquito ditch maintenance and pesticide spraying.

HLR-8.1: Encourage cooperation among governmental agencies to plan and implement Open Marsh Water Management (OMWM) to manage tidal wetlands with grid ditches for mosquito control with the goal of also restoring more natural conditions.

HLR-8.2: Develop recommendations in the PEP Habitat Restoration Plan for control of *Phragmites australis* by restoration of natural processes such as removal or modification of flow-restriction devices, removal of hardened shorelines, and revegetation of bay and creek shoreline or by other means.

The CCMP notes suspicions that the application of pesticides and herbicides may be related to declines in eel grass beds.

HLR-16.6: Research the lethal, sublethal, and synergistic effects of elevated nutrients, toxic chemicals, and Brown Tide on the reproduction and behavior of finfish and invertebrate species.

Page 6-9 of the Plan states:

> Vector control ditches (mosquito ditches) are maintained by the Suffolk County Department of Public Works (SCDPW), which typically applies sprays for larval control of mosquitoes. Problem areas are monitored to determine effective treatments. The primary insecticide used is Bti (bacillus thuringiensis var, israelensis); in some areas methoprene is used. The use of mosquito larvicides in storm drains and catch basins has been advocated as a mosquito control measure. This could contribute larvicides to surface waters following rainfall events. Recently, the pesticide malathion has been applied in residential areas. Malathion is labeled for use on adult mosquitoes and cannot be applied to water.

That leads directly to the following recommendation:

T-7.3: Reduce the use of insecticides for mosquito control to the maximum extent practicable [but maintain levels] that still adequately protect human health. [C]onsider adverse impacts on the environment in insecticide selection. Encourage good housekeeping methods of control, such as eliminating/reducing standing water that functions as breeding sites.

Other recommendations related to this include:

T-4.1: Continue to pursue development/establishment of the Long Island Pesticide Management Plan and enforceable Statewide agricultural pesticide program requirements under CZARA, which reduce the potential for contamination of surface water and ground water due to the application of pesticides. In the meantime, seek commitments on a voluntary basis from landowners to comply with this measure.

T-4.3: Ensure that commercial pesticide applicators, and applicators of restricted use pesticides, are properly certified.

T-4.4: Enforce the provisions of the State's Freshwater Protection Law to reduce or eliminate loadings of pesticides and herbicides on or in the vicinity of wetlands and associated waterbodies.

T-4.5: Develop and implement integrated pest management (IPM) programs that manage pests with minimal impact on human health and the environment.

T-4.9: Restrict or ban pesticides whose residues are frequently detected at levels of environment or public health concern in groundwater or the estuary.

The following was added in Appendix L (Response to Public Comments) to clarify the PEP position on pesticides:

The PEP is supportive of the use of integrated pest management (IPM) on golf courses and farm fields, the general lessening of pesticide applications, implementation of "clean sweep" programs and the development of a Long Island Pesticide Management Plan, and instituting bans or restrictions on particular pesticides,

4.4 The Long Island Comprehensive Special Groundwater Protection Area Plan (Long Island Regional Planning Board, 1992)

The focus on groundwater protection in all environmental planning means that this plan, written to provide protection to key areas of the deep recharge system, bears consideration.

The areas of greatest concern are identified as "special groundwater protection areas" (SGPAs). In Suffolk County, there are a total of seven SGPAs. Maps of these areas are provided in the SGPA Plan. These areas are:

- West Hills-Mellville SGPA
- Oak Brush Plains SGPA
- South Setauket Woods SGPA
- Central Suffolk SGPA
- South Fork SGPA
- Hither Hills SGPA
- Southold SGPA

These SGPAs are considered "critical environmental areas" pursuant to SEQRA.

The general discussion of pesticides applications, best management practices, and reducing impacts to groundwater supplies focuses on agricultural pesticide applications. It recommends use of IPM to minimize the impacts. The statement of IPM in the plan is as follows:

- Establish and use economic thresholds for pest management and control.
- Use biological controls when possible and practical.
- Use the minimum quantity of pesticide needed for proper control.
- Use pesticides having the least negative environmental effect with particular attention to groundwater.
- Make best use of cultural practices such as crop rotation, resistant or tolerant varieties, time of planting, spacing, and use of mulch to prevent disease, weed and insect problems.

The first four components clearly are applicable to IMM as well. The plan further states:

> In order for agricultural land uses to co-exist with groundwater protection, the agricultural industry must follow best management practices to minimize the leaching of fertilizers, and pesticides or their components to groundwater. … Pesticides are necessary to control some of the persistent pests, but awareness of soil properties, correct timing, increased reliance on biological controls and use of pesticides at the lowest effective application rate may reduce the need for agricultural chemicals and lessen the resultant impact on the water supply.

The general applicability of these guidelines to mosquito management chemical use as well seems clear.

4.5 Central Pine Barrens Comprehensive Land Use Plan (Central Pine Barrens Joint Planning and Policy Commission, 1995)

The *Central Pine Barrens Comprehensive Land Use Plan* is a major land use management and groundwater protection initiative in Suffolk County. The drafting of the Plan was authorized pursuant to the Long Island Pine Barrens Act enacted by the New York State legislature in 1993. The Act represents an amendment to the Environmental Conservation Law Article 57, Long Island Pine Barrens Maritime Reserve Act of 1990. The designated Central Pine Barrens area is significant as it comprises a total of 100,000 acres including a 52,500-acre Core Preservation Area and 47,500-acre Compatible Growth Area.

The legislation states that:

> The land use plan for the Central Pine Barrens area shall be designed to:
>
> (a) protect, preserve, and enhance the functional integrity of the Pine Barrens ecosystem and the significant natural resources, including plant and animal populations and communities, thereof;
>
> (b) protect the quality of surface water and groundwater;
>
> (c) discourage piecemeal and scattered development;
>
> (d) promote active and passive recreational and environmental educational uses that are consistent with the land use plan; and
>
> (e) accommodate development, in a manner consistent with the long term integrity of the Pine Barrens ecosystem and to ensure that the pattern of development is compact, efficient and orderly.

Freshwater wetlands that exist within the Central Pine Barrens and tidal wetlands existing within the marine environment bordering the Central Pine Barrens are considered to be an important natural resources. Many general and specific guidelines were given for their protection. Particular recommendations included:

7.6.4.1 Protect and preserve tidal wetland values.

7.6.4.2 Restore those tidal wetland areas diminished by manmade activities.

For fresh water wetlands, relevant recommendations include:

7.6.3.1 Structural and nonstructural mitigation measures should be designed and installed where practical and economically feasible for existing direct stormwater discharges to wetlands. Runoff control structures should be designed to both protect wetlands ecology and provide flood control.

7.6.3.2 Surface drainage from future development should not be discharged directly to these wetlands, or otherwise significantly impact the hydrologic regime of wetlands (timing, duration, magnitude, frequency of water inputs).

7.6.3.3 Physical disturbance or removal of vegetation in or adjacent to wetlands should be avoided with the exception of that associated with the creation of educational or interpretive facilities and agency approved public recreational uses.

7.6.3.6 Where scientifically justifiable, active management by cutting, fire, removal of invasive species, or other techniques may be used to prevent the loss of wetland communities or species (e.g., the use of fire for regeneration of white cedar stands or the removal of phragmites). Potential ecological impacts of such management, including not actively managing such sites, should be carefully examined.

Please note the following:

> Coastal plain ponds and pond shores harbor the highest concentrations of rare species in the Central Pine Barrens, and are especially ecologically sensitive. These ponds may require a higher level of protection than other wetland types.

Recommendation 7.6.3.6 is especially interesting, in light of these two other recommendations:

7.6.5 Restoration of degraded habitats on public lands: ecological restoration is the practice of returning damaged or degraded areas to some semblance of their predisturbance condition.

> The goal of restoration is to emulate a natural, functioning, self regulating system that is integrated with the ecological landscape in which it occurs. In a successfully restored ecosystem "...natural processes, including evolution, proceed, with the bulk of the biodiversity surviving" (Packard 1993). The aim of restoration is not to recreate the past, but to use the past "...as a reference point for the future" (Falk 1990). Ecosystems and living organisms never stop changing; this capacity for change must be maintained in any restored ecosystem.
>
> In most cases habitat restoration on public lands may be achieved by understanding and then redirecting injurious human activities (a process which also addresses cultural restoration). Many ecosystems will recover through the process of natural succession; however, there are possible exceptions to this "laissez faire" method. Exceptions include wetlands that have been impacted by development that has resulted in degraded water quality and possibly altered hydrologic regimes, severely denuded and eroded areas such as defunct sand mines and other developed areas where nonnative plant species present threats to adjacent natural pine barrens, and areas where disrupted ecosystem processes have caused losses of pine barrens diversity. Active intervention may be required in such cases. The Protected Lands Council should consider and prioritize the need for specific restoration efforts in specific public lands. Plans for restoration should be made on a site specific basis, restoration projects should use appropriate local native stock and materials, should model indigenous pine barrens ecosystems, and should address associated sociocultural issues

7.5.3.5 Active management of lands and waters supporting wildlife and fish should continue, including the creation and maintenance of food plots, and activity sites for hunting, fishing, trapping and associated activities, the stocking of indigenous and nonindigenous species, the enhancement of wetlands, and other actions which will insure the abundance of wildlife and fish populations within the public lands of the Central Pine Barrens.

These two recommendations, at first glance, appear to be in some conflict. The first seems to describe restoration largely as a laissez-faire practice, while the second calls for active management of many systems. It is not clear what the preferred nature of "salt marsh restoration" might be under this plan, for example. Would it be considered under continuation of active management of the environment, or should it be perceived as one of the situations where natural succession should be allowed to move forward?

There were two specific recommendations relating to mosquito control particularly:

7.6.1.5 Review and consider alternative control methods to aerial or broadcast spraying of pesticides (e.g., for gypsy moths, mosquitoes) and limit chemical use as much as

possible. The impact of pest control measures upon nontargeted species should be evaluated.

7.6.2.4 Review and consider alternative control methods to aerial or broadcast spraying of pesticides, and limit chemical use as much as possible. The impact of chemicals used on nontargeted species should be evaluated. When chemical use is necessary, pesticides and methods which minimize effects on nontargeted species should be utilized.

4.6 Long Island Wetlands Restoration Initiative

The Long Island Wetlands Restoration Initiative strives to restore Long Island's wetlands including those which serve as breeding areas for mosquitoes. The initiative was created among four cooperating organizations:

- Ducks Unlimited (a private, nationwide conservation organization, supported primarily by contributions from waterfowl hunters)
- USFWS (Long Island National Refuge Complex)
- NYSDEC Region I
- SCDPW (in particular, SCVC)

A Memorandum of Understanding (MOU) was prepared for these organizations, describing their joint interests in restoring wetlands on Long Island, and detailing the degree of cooperation that each would provide to foster restoration activities. Primarily, each organization pledged to review any potential wetland restoration at the pre-permit stage, and then, if it so chose to do so, to participate and assist in the project as willing and able. The MOU was signed by the participants at a public ceremony at Bethpage State Park on May 7, 1997 (Long Island Wetland Restoration Initiative, 1997; C. Kessler, Ducks Unlimited, personal communication, 2004).

A brochure produced by Ducks Unlimited regarding the Wetlands Initiative (and approved by the other three cooperators) described its goal as the restoration of 10,000 acres (over a ten year period), encompassing locations along all of Long Island from Jamaica Bay on the south shore out through the Hamptons, throughout the Peconic Bay system, and then along the north shore from Fishers Island west to Flushing Bay. Nine specific measures were identified:

- Restoration of tidal flows
- Removal of spoil from wetlands
- Open marsh water management in ditched salt marshes

- Open marsh water management in ditched riverine marshes
- Containment and reduction of Great Reed [*Phragmites*] and other invading exotic vegetation/habitats
- Management of coastal impoundments
- Restoration of sea grass beds in subtidal habitats
- Management/enhancement of uplands adjacent to coastal wetlands
- Land preservation of critical wetland and associated upland habitats (Ducks Unlimited, undated)

Re-evaluation of the stated goals by some of the participants has led to an immediate focus on addressing formerly-connected wetlands first. A site in the State wetlands at Beaverdam Creek (Brookhaven hamlet) was selected through a screening of 30 potential sites. The Taskforce for this project, chaired by Craig Kessler of Ducks Unlimited, has advanced the project to where the pre-construction designs appear to be ready for general approval by the Initiative (C. Kessler, Ducks Unlimited, personal communication, 2004).

5 Local Plans

Local plans may have some relevance to conducting County mosquito control operations, if only to ensure there are no major conflicts between local concerns and initiatives and those of the County overall. However, other than general environmental concerns for wetlands, water quality, and overall health and safety issues (minimization of pesticides use, for example), most Comprehensive Plans may not explicitly discuss mosquito management measures.

Two plans were examined in detail. The Town of Southampton Comprehensive Plan (Land Ethics, 1999), under the Wetlands Streams and Surface Waters Action Items, did note the following (which are or may be pertinent to mosquito control):

- Complete wetland restoration efforts identified by the Southampton Town Department of Land Management.
- Strictly enforce section 111-28 to conserve barrier island vegetation due to its significance for rare migratory birds and Lepidoptera.
- Establish coastal ecological preserve areas, giving priority attention to designated fish and wildlife habitat areas, and rare or particular valuable wetland and aquatic community types.
- Develop coordinated management plans for all of the Town-identified significant natural areas.
- Develop habitat restoration policies and environmental performance standards relative to theses policies.
- Target Reeves Bay as a pilot restoration area to develop a multi-tiered approach to habitat destruction, biodiversity loss, water quality degradation, and contaminated shellfish beds.
- Develop partnerships with local conservation organizations, civic groups, and academic institutions to assist in the rehabilitation and restoration of damaged wetland areas.

The Town of East Hampton Comprehensive Plan (Horne Rose, 2003) is an example of a plan where no specific references to OMWM, wetlands restoration, pesticides use (other than agricultural reference) or mosquito management appear. General references are on the order of:

> Take forceful measures to protect and restore the environment, particularly groundwater. Reduce impacts of human habitation on ground water, surface water, wetlands, dunes, biodiversity, ecosystems, scenic resources, air quality, the night sky and energy consumption.

or

> Take forceful measures to protect and restore the environment, particularly groundwater. Reduce impacts of human habitation on ground water, surface water, wetlands, dunes, biodiversity, ecosystems, scenic resources, air quality, the night sky and energy consumption.

The drafting of new plans is occurring all of the time. It will be important to keep abreast of new planning initiatives and to keep communications open between all levels of government and geographic jurisdictions to ensure consideration, consistency, or compliance with laws and policies.

Other special purpose and district plans and studies more directly address vector control issues. LWRPs are good examples. These may specifically discuss how sections of the waterfront should be managed, and so may either be of use in devising or be in conflict with mosquito management goals. Three LWRPs were examined in detail to find examples of the kinds of management initiatives they may contain.

5.1 Draft Mastic Beach Shirley LWRP (Cashin Associates, 2003a)

These policies in particular apply to mosquito management:

Policy 5: Protect and restore ecological resources, including significant fish and wildlife habitats, wetlands, and rare ecological communities.

Policy 5.5: Protect and, to the extent practicable, restore existing tidal and freshwater wetlands.

Policy 5.6: Undertake mosquito control programs in a manner that does not result in significant adverse impacts to tidal and freshwater wetlands. Increased publicity recently has been given to the occurrence of mosquito-borne diseases in coastal areas in the Northeast region. The development of mosquito larvae requires standing water, which typically is found extensively in wetland areas, such as are present in abundance within the LWRA and adjacent areas. In the past, one strategy to address this issue has been to excavate ditches at regular intervals across marsh surfaces. However, subsequent experience has revealed that this method, while it may provide some initial relief from mosquito infestations, generally is unsatisfactory over the long term.

Grid ditching has been found to result in adverse ecological effects to the wetlands. Ironically, inadequately maintained ditches often result in flow disruptions that create ideal breeding habitat for mosquitoes, thereby counteracting the purpose for which the ditches originally were constructed. Present-day scientific knowledge holds that restoring a more natural marsh system, with ditching placed only at strategic locations to allow larvae-consuming fish access to mosquito breeding areas, provides more effective mosquito control and does not adversely disrupt wetland ecology. In the spring of 2000 the William Floyd Estate underwent this type of marsh restoration program, generally referred to as Open Marsh Water Management. Anecdotal reports from residents in the adjacent areas indicate that mosquito counts during the following summer were significantly reduced compared to prior years.

Mosquito control is an important concern to the residents of the Mastic-Shirley peninsula, due to the occurrence of extensive areas of tidal and freshwater marshes in this area and neighboring locations. In addressing this issue in the LWRA [Local Waterfront Revitalization Area], care must be taken to avoid the types of mistakes that were made in the past. Decisions should be directed at identifying and implementing actions that provide effective reduction of mosquito populations, while also ensuring that adverse impacts to wetlands are avoided.

Policy 6: Protect and improve water resources.

Policy 6.3: Reduce non-point pollution using management measures that are targeted to the specific land use and pollution source categories that apply to the LWRA.

3. For hydro-modifications (i.e., actions involving alterations of flow volume, velocity or patterns, or other hydraulic characteristics of surface water bodies), the following policies shall be applied: … Manage wetlands that have been channelized to simulate natural hydrology. The dead-end canals on the east side of the William Floyd Parkway are especially prone to water quality problems, and should be given special attention in any program to enhance coastal water quality in the LWRA.

5.2 Southold LWRP (Scopaz with Ridler, 2003)

Two sections in particular appear to be pertinent.

6.3 Protect and restore tidal and freshwater wetlands.

C. Prevent the net loss of vegetated wetlands according to the following measures. Use the measure resulting in the least environmentally damaging practicable alternative.

6.3.C.3.e.(i) Do not fill, excavate, or dredge vegetated wetland areas which:

a) support endangered or threatened species of plants or animals

(b) have not been subjected to significant impairment, or

(c) are part of a natural resource management area, including refuges, sanctuaries, reserves, or areas designated as Significant Coastal Fish and Wildlife Habitats, based on wetland values

(ii) Do not fill, excavate, or dredge vegetated wetland areas when the wetland loss would result in significant impairment of the remaining wetland area.

(iii) Retain functions and benefits associated with vegetated and non-vegetated wetlands.

E. Restore tidal wetlands and freshwater wetlands, wherever practical, to foster their continued existence as natural systems by:

1. reconstructing lost physical conditions to maximize wetland values,
2. adjusting altered chemical characteristics to emulate natural conditions,
3. manipulating biological characteristics to emulate natural conditions through reintroduction of indigenous flora and fauna, and
4. protecting lands adjacent to wetlands from alterations so as to maximize natural buffers to wetlands.

6.11 Open Marsh Water Management

The Town has successfully partnered with or supported efforts to restore and manage open marsh water management. Currently the Orient marshes are the focus of a management project. This program needs to be extended to other open marsh areas within town.

5.3 Draft Huntington LWRP (Cashin Associates, 2003b)

The following initiatives appear to impact mosquito and wetlands control measures:

4.2. Preserve and restore natural protective features.

Natural protective features (e.g., beaches, dunes, shoals, bars, spits, barrier islands, bluffs, wetlands, and associated natural protective vegetation) provide natural protection against coastal erosion and flooding by absorbing the energy of storm surge and waves, thereby reducing storm impacts on inland areas. The intent of this sub-policy is to ensure that development and other human activities do not decrease the natural protective capabilities of these features. … Maximize the protective capabilities of natural protective features by: avoiding alteration or interference with shorelines in a natural condition; enhancing existing natural protective features; restoring impaired natural protective features; and managing activities to minimize interference with, limit damage to, or reverse damage which has diminished the protective capacities of the natural shoreline.

6.3. Restore degraded wetlands in the LWRA.

Over the years, human activities within the LWRA have caused the direct loss of significant areas of tidal wetlands, as well as indirect impairments to this important ecological resource. The intent of this sub-policy is to encourage wetland restoration projects, which would reverse this historical trend and enhance the LWRA's natural resource value.

8.3. Protect the environment from degradation due to toxic pollutants and substances hazardous to the environment and public health.

Protect public health, public and private property, and fish and wildlife from inappropriate use of pesticides.

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Table 2-1. NYSDOH Four-Tiered WNV Strategy (NYSDOH, 2001)

Tier	Circumstances	Response
I	No historical or current evidence of virus No neighboring Health Unit with historical/current evidence of virus	Level 1 education campaign Enhanced passive human/bird surveillance Consider adult mosquito surveillance (species, distribution) Lower priority for lab testing Consider larval surveillance Consider local environmental assessments Consider local disease risk assessments
II	Historical evidence of virus Neighboring Health Units with historical evidence	Level 1 enhanced education program (general community & provider community) Local environmental assessments Local disease risk assessments Active human (if evidence in-unit)/bird surveillance Larval surveillance Larval habitat source reduction Larval control Adult surveillance and lab testing
III	Current virus isolation/evidence of infection in individual locations	Level 2/3 education program (general public & provider community) Active human/bird surveillance Larval surveillance Larval habitat source reduction Larval control Adult surveillance and lab testing Adult control, ground application
IV	Current virus isolation/evidence of infection in multiple locations	Level 2/3/4 education program (general public & provider community) Active human/bird surveillance Larval surveillance Larval habitat source reduction Larval control Adult surveillance and lab testing Adult control, ground application

Appendix

Mosquito Surveillance and Management Protocol

Fire Island National Seashore – 2002

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The purpose of this plan is to present a surveillance protocol to monitor mosquito populations from Fire Island National Seashore and to test mosquitoes for evidence of arboviral infection. Surveillance efforts focus on possible mosquito infection with Eastern Equine Encephalitis virus (EEE) and West Nile Virus (WNV).

Fire Island National Seashore will carry out a sanitation program to reduce artificial *Culex* larval habitat on lands administered by the National Seashore, and will institute this surveillance and management protocol to minimize any risk of viral transmission.

The plan outlines appropriate additional actions if data indicate increasing risk of mosquito-borne disease.

In light of continued uncertainty over how West Nile Virus and other mosquito-borne diseases will manifest themselves in the Western Hemisphere this year, proactive management is again proposed for 2002 and will follow very similar protocols to those used in the last three years. These guidelines will continue to be reexamined in subsequent years, based on increased knowledge of and experience with arboviruses in this area. The need for responses based on unpredictable trends in the spread of viruses requires that a consultation process be established that will allow appropriate responses to changes in mosquito populations and viral infection patterns as they occur. This consultation includes NPS, other DOI, CDC, NY State, Suffolk County, and/or local experts. The consultation process ranges from communication between park staff and local, state, or Federal experts via telephone, FAX, or e-mail, to scheduled meetings and site visits, depending on the degree of risk of local viral transmission.

Criteria for active management within the park:

Presence of WNV in or near the park, or of EEE in the park, or extraordinarily persistent and/or high levels of EEE infection in mosquitoes near the park, could trigger interventions within the park if conditions are such that:

1) the conditions strongly suggest disease risk to humans;
2) the risk of disease transmission would be substantially lowered by the intervention; and,
3) mosquito management within the park is superior to other available approaches to manage disease risk.

The decision to apply mosquito management interventions will depend on the intensity and persistence of viral activity, proximity of viral activity to mosquito emergence sites within Fire Island National Seashore, time of year, mosquito population levels, etc. Because these conditions vary from year to year, and cannot be predicted, this consultation process will be used to determine whether interventions within the park are warranted, on a case by case basis.

Interventions can include closing portions of the park to the public, mosquito management methods such as applications of *Bacillus thuringiensis israelensis* (*Bti*) or *Bacillus sphaericus* (*Bs*) to prevent emergences, or adulticide applications to areas with high levels of adult *Culex* spp. or *Ochlerotatus (formerly Aedes) sollicitans*. The final decision on all management interventions within Fire Island National Seashore, including the William Floyd Estate, will be made by the Park Superintendent in accordance with NPS Management Policies.

Specific criteria for level of surveillance and management:

Three levels of action are proposed:

1. Surveillance and Education
2. Detection and Public Notification
3. Mosquito Management.

Based on monitoring data, guidelines are presented for deciding what criteria would result in a move to the next higher level of surveillance and management. Arrangements to send

mosquitoes for viral testing should be completed by the end of June at the latest. Similarly, arrangements for pesticide applications or other management interventions (to be applied if necessary, according to this protocol) should be completed by the end of June. These arrangements will include permit approval, arranging for applicators, etc. Decisions to move to higher levels will be made by park staff, in consultation with appropriate experts.

Level 1 - Surveillance and Education

Education consists of park brochures, interpretive programs, etc., to inform the public about mosquitoes, their roles in natural systems, potential disease transmission, and associated surveillance and management programs. Basic surveillance consists of passive surveillance for dead birds, and mosquito monitoring including larval monitoring with pint dippers and adult monitoring using CDC miniature light traps baited with carbon dioxide, and gravid traps.

The gravid traps are intended to sample gravid *Culex* spp., and to be sensitive indicators of the presence of WNV. The CDC traps are intended to sample host-seeking female mosquitoes of several species (including *Ochlerotatus sollicitans* and *Culex* spp.) to provide broader surveillance of viral infection in potentially human-biting mosquitoes. Therefore, gravid traps will be placed in or near potential *Culex* larval habitat, and CDC traps will be placed at sites where mosquitoes are likely to encounter humans, or between mosquito breeding sites and potential human-encounter sites. Guidance for trap placement will be obtained from the report *Distribution and dispersal of mosquitoes, Fire Island National Seashore* (H.S. Ginsberg & F.J. Rohlf. 1985. Report #OSS-86-1, National Park Service, Boston, MA) and by consultation with mosquito biologists.

One gravid trap will be placed near the freshwater wetlands in the secondary dune area at Hospital Point, and one CDC trap will be placed in the woods in the Smith Shores area between the Hospital Point marsh and the Smith Point Ranger Station. At the William Floyd Estate (WFE), one gravid trap will be placed in moist woodland habitat and one gravid trap will be placed near the salt marsh/woods border. Additional traps may be placed at any freshwater swamp sites that have potential for *Culiseta melanura* breeding.

Additional traps will be set at other sites along Fire Island, as follows:

- One gravid trap will be placed near the Watch Hill/Davis Park border.
- One gravid trap will be placed near the park houses at Watch Hill.
- One CDC trap will be placed at Sailors Haven
- One gravid trap will be placed in the Sunken Forest
- One gravid trap will be placed in or near wetlands in the Lighthouse tract.

Guidance for trap placement is obtained from the report "Distribution and dispersal of mosquitoes, Fire Island National Seashore" (H.S. Ginsberg & F.J. Rohlf. 1985. Report #OSS-86-1, National Park Service, Boston, MA) and by consultation with mosquito biologists.

This initial distribution of traps may be modified based on surveillance results. For example, if there are positive results in birds or mosquitoes in an area, additional traps will be added to this area to get more complete information about the local epizootiology of the virus.

Traps will be set once each week, June – September (traps at different sites may be placed on different nights, to facilitate timely setting and collecting of traps). Trap catches will be sorted to species, and the number of *Culex* spp. – and other mosquito species as time permits – will be counted. During large emergences, trap counts and species composition will be estimated using appropriate techniques.

Virus testing: mosquitoes captured in the surveillance traps will be sorted to species and placed in pools using appropriate techniques. A pool will consist of up to 50 mosquitoes of a single species from a single trap (pool size is recommended by testing lab). Pools of *Culex* spp. (if present) will be sent to the laboratory for detection of WNV and EEE virus by cell culture, or other technique approved by Park staff. Pools of other species can also be sent for viral testing, at the discretion of Park staff.

Larval monitoring: mosquito larvae will be monitored using a pint dipper. Sampling sites will be selected by reference to Ginsberg & Rohlf (1985) and/or by consultation with mosquito biologists, and modified by current experience. At least 25 dips will be taken at each site, the larvae counted, and representative specimens returned to the lab to confirm identifications (see Ginsberg & Rohlf 1985), as time permits. Larvae will be sampled at sites near the gravid traps at least once per month in the absence of WNV. Should virus be found in the seashore, larvae will be sampled as often as recommended by mosquito experts.

Passive monitoring for dead birds will include alerting park rangers, interpreters, and resource management staff to be on the lookout for dead birds. Reports of bird mortality will be

investigated by resource management staff, and candidates for possible viral infection will be collected and submitted for testing using a protocol developed by the park in accordance with guidelines from the U.S. Fish and Wildlife Service, the Centers for Disease Control, New York State and the Suffolk County Health Department.

Criteria for move to Level 2:

Substantial mosquito trap catches will result in a move to Level 2. The term "substantial" is defined as a catch of over 1,000 female mosquitoes in a carbon dioxide-baited CDC light trap from Fire Island, or of over 100 individuals in a trap on the William Floyd Estate. Also, detection of WNV or EEE virus in birds, mammals, or mammal-feeding mosquitoes on Fire Island or at mainland Long Island sites within five miles of Fire Island or of the William Floyd Estate will trigger an increase to Level 2 surveillance. Detection of EEE virus in bird-feeding mosquitoes (e.g., *Cs. melanura*) will trigger a move to Level 2 if there are signs of higher than normal prevalence (e.g., at least three pools of *Cs. melanura* positive for EEE within five miles of Smith Point or of the William Floyd Estate).

Level 2 - Detection and Public Notification

The park will notify Suffolk County Vector Control of the results of the surveillance program. If WNV or EEE is detected within the park, visitors to the park will also be notified about mosquito densities, possibility of viral infection (realistic assessment), and self-protection methods they can use to minimize the number of mosquito bites. Arrangements will be finalized for pesticide application in case conditions warrant such intervention (this should be coordinated with Suffolk County Vector Control). Consultation will be initiated between Fire Island National Seashore and Suffolk County Vector Control, New York State Health Department, Centers for Disease Control, U.S. Department of the Interior, and/or experts from universities or other institutions to guide the Park Superintendent on potential courses of action. Larval management in artificial sites will be intensified and surveillance will continue.

Criteria for move to Level 3:

Detection of WNV in a potential human biter (e.g., *Culex* spp. or *Oc. sollicitans*), or of EEE in a potential epidemic vector (e.g., *Oc. sollicitans, Coquillettidia perturbans*) in the park will trigger the consultation process to assess the risk of disease transmission. In general, single positive mosquito pools will result in intensified surveillance (increased trapping and larval sampling), and multiple positive pools will result in an increase to level (3). Signs of increasing WNV epizootic activity (e.g., positive birds followed by positive mosquito pools, or multiple and increasing numbers of positive birds over a two-week period) can result in an increase to Level 3, based on the consultation process. Detection of WNV or EEE in potential epidemic vectors outside but near the park, persistent high levels of EEE in *Cs. melanura* at sites within 5 miles of the park (at least three EEE isolations at a site in consecutive samples taken within one month) at the same time as evidence of an imminent emergence of *Oc. sollicitans*, or other evidence of EEE activity (e.g., animal cases) within 5 miles of the park will trigger the consultation process to assess the risk of disease transmission. The consultation can result in an increase to Level 3 if such action is deemed appropriate by the Park Superintendent after consultation with the appropriate experts and in accordance with NPS Management Policies.

Level 3 - Mosquito Management

The approach to mosquito management will depend on the nature of the disease risk, as projected from the surveillance data. Detection of EEE activity by PCR or ELISA is not, by itself, sufficient evidence of EEE activity to trigger mosquito management within the park. EEE activity must be detected by cell culture, or by other suitably rigorous technique approved by park staff, before mosquito management is initiated in the park. Detection methods for WNV will be based on Centers for Disease Control (CDC) recommendations and approved by park staff.

(3a) Epidemic vector infected with EEE in Fire Island National Seashore

i. EEE detected in *Oc. sollicitans* (or other potential epidemic vector) on Fire Island.

Intervention: Application of adulticide (resmethrin, permethrin, or other material approved by park staff) to Fire Island, if appropriate according to consultation process. Pesticide will be applied to the site of viral identification and to the barrier island for distances in both directions from the identification site(s) determined by the consultation process, and stopping at appropriate natural borders. Multiple viral isolations can result in more extensive adulticide application, determined by the consultation process, based on specifics of viral spread. Similarly, single isolations at remote sites can result in less extensive, finely-targeted application(s). Larviciding can occur in natural areas with high larval densities of potential vector species.

ii. EEE detected in *Oc. sollicitans* (or other potential epidemic vector) at the William Floyd Estate.

Intervention: Application of adulticide to the William Floyd Estate, if appropriate according to consultation process.

iii. Potential human vector mosquito species positive for WNV in an area with previously-demonstrated epizootic activity (previous positive mosquito pools or multiple positive vertebrates)

Intervention: Based on consultation process. A single mosquito pool positive for WNV would typically result in increased trapping to assess risk of human disease. Multiple positive pools in an area with previously-demonstrated epizootic activity could result in adulticide and/or larvicide application, as in (3a) (Section i).

(3b) Multiple WNV or EEE detections in vertebrate(s) in Fire Island National Seashore

Intervention: Based on consultation process. Interventions can include increased mosquito trapping and testing, and increased larval management and/or adulticiding when there is evidence of intensive epizootic activity (e.g., numerous or increasing numbers of positive birds within a two-week period, or positive birds coupled with positive mosquito pools), especially when accompanied by high mosquito numbers (e.g., *Culex* trap catch > 50 females/trap; *Oc. sollicitans* trap catch > 200 females/trap).

(3c) WNV or EEE detected outside but near the park, or in enzootic vectors within the park, with current or imminent emergence of epidemic vector species within the park.

i. WNV

Multiple evidence of WNV in mosquitoes or vertebrates within two miles of Fire Island National Seashore can trigger adulticide application within the park if populations of *Culex* spp. are high (trap catches >500 females in carbon dioxide baited CDC light trap on Fire Island, >50 females in CDC trap at WFE) or of *Oc. sollicitans* are high (trap catches >2,500 females in CDC trap on Fire Island, >250 females in CDC trap at WFE) in park areas within two miles of the viral isolations. Location and extent of application will be based on consultation process. Response at lower adult densities, especially with evidence of imminent emergence from larval samples, will be based on the consultation process.

ii. EEE

Evidence of EEE within 5 miles of Fire Island National Seashore, or in *Cs. melanura* within the park, will trigger the consultation process. Park staff will contact the CDC (initially by phone, FAX, or e-mail, with more comprehensive consultation only if necessary), NY State, Suffolk County, U.S. Department of Interior, university, and/or other experts as needed. If conditions warrant (according to the CDC and in consultation with other appropriate experts, to lower the risk of human disease) appropriate interventions can be applied in accordance with NPS Management Policies.